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ANNALS *of* SURGERY

Vol. XC DECEMBER, 1929 No. 6

THE PROBLEM OF RHINOPLASTY *

By Howard L. Updegraff, M.D.

of Hollywood, Calif.

The problem of rhinoplasty is one of increasing interest because of the number of successful cases yearly being reported. With the thought of further simplifying the necessary procedures this paper is presented.

Historically, 1918 furnishes us with a dividing line. In earlier years, Taliocozzi,[1] Nelaton, Ombridanne and many others, without the benefit of anæsthesia, asepsis, and adhesive plaster, had developed the idea of the forehead flap. By 1918 the influx of war facial deformities had created a renewed interest in rhinoplasty, and caused the elevation of plastic surgery into a specialty *per se, reconstructive* surgery.

Fig. 1.—Typical case applying for rhinoplasty. Lupus vulgaris.

The etiological factors necessitating rhinoplasty include lues, cancer, lupus, radium and X-ray burns, cancer pastes, plasters and acids, trauma, paraffinomas and infections.

The preliminary considerations involving successful operative procedure depend first on etiology. The amount of involvement of tissue and the condition of the remaining available reconstructive base demand consideration. If one or both canthi are involved the question of lachrymal duct treatment or obliteration arises. Sex is important in that the mode of dressing the hair in the female ofttimes is the deciding factor of changing an uncoverable defect of the nose to a concealable one of the forehead. Incidentally which way the hair is parted ofttimes decides the direction of the flap when the nasal defect is centrally located. The psychology of the patient is vital. A poor result will please one—an excellent result will offend another. The glandular syndrome as reflected by temperament may be an index of not only the patients' coöperation but their healing power.

The type of skin is one of environment and age. A majority of cases are those of cancer and lupus age or past. A high forehead with receding temple hair is a distinct advantage in that the flap can be cut high and curved,

* Presented before the Hollywood Academy of Medicine, July 2, 1929.

FIG. 2.—Cancer paste for supposed malignancy.

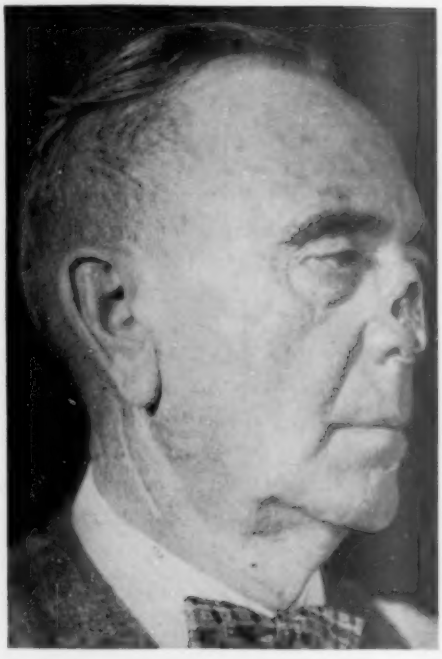

FIG. 3.—Epithelioma—surgical removal. Seemingly small nasal opening due to falling in of tissue, most of which unavailable for reconstruction.

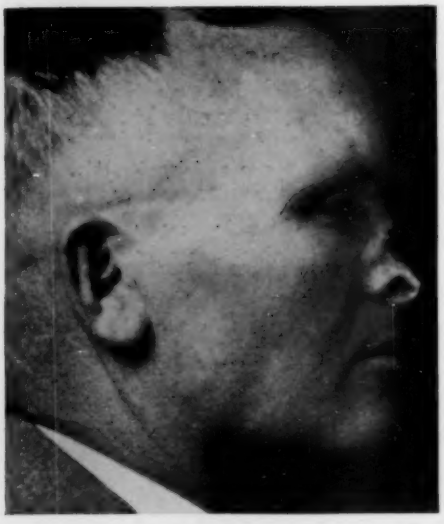

FIG. 4.—Same case as Fig. 1. Note amount of septum deficiency.

FIG. 5.—Same case as 2. Cancer paste has destroyed left nasal bone and lachrymal duct.

FIG. 6.—Same case as 3. Following surgical removal of epitheliomata.

FIG. 7.—Plaster cast of case in Figs. 1 and 3. Shows tinfoil on forehead designating amount of forehead skin necessary to form nose.

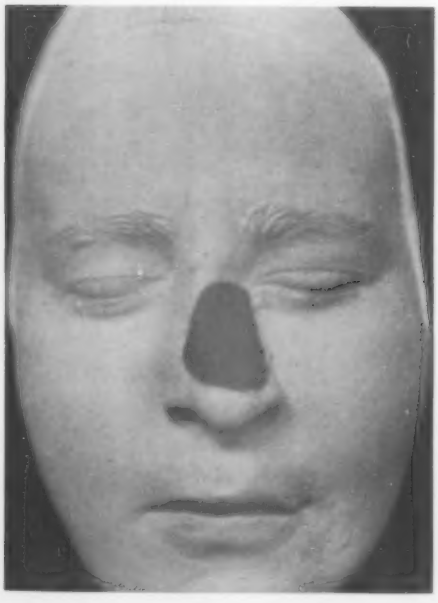

FIG. 8.—Note amount of canthus involvement. Same case as Figs. 2 and 5.

FIG. 9.—Note amount of tissue necessary to supply deficiency as indicated by modeling clay. Same case as Figs. 3 and 4.

and skin taken from the temple area is more acceptable without hair as this portion of the flap forms the nose. At least the bald-headed man has one thing for which to be thankful.

FIG. 10.—Glue cast of preceding cases 1, 4 and 7. Shows leather flap folded to mold columella and additional piece to demonstrate Wolfe graft lining.

The amount of the nose to be reconstructed may seem at first glance to be small. (Fig. 1.) Examination may reveal much thin scar tissue useless for attaching a flap. The nasal arch, if persistent and high, may spoil the line of the new nose to the extent that partial removal is advisable. The septum is not of great moment as the flap is not attached to it except at the columella and the profile deficiency (Fig. 4) can in large part be supplied by the thickness of the free graft used to line the flap as advocated by New.[2] If portions of both alæ can be preserved and utilized the attendant alar flair is a very acceptable contribution.

The mental preparation of the patient is of importance as the average rhinoplasty will take three or four stages, extending over a period of three months. The patient has no way of knowing or comprehending the amount of personal time given to detail by the surgeon. Consequently, the thought of the financial outlay necessary for hospitalization influences many to the use of prosthesis or further attempts at healing.

FIG. 11.—Crinoline may be used instead of leather to make trial flap on glue cast.

A patient is naturally hesitant in starting on a prolonged period of hospitalization without some reassurance that the etiological factor will not recur. In lues, specific treatment will be of value but not of necessity, inasmuch as the necrotic bone and septum are not replaced but rather the defect covered. Again, the tertiary stage of which the caries is indicative is not a stage necessarily where absence of skin healing and lowering of resistance to infection are especially evident. Total rhinoplasties on luetic patients with a two plus Wassermann and no treatment

have been done successfully by Sheehan.[3] Lupus vulgaris cases have a good chance for permanent recovery according to Roen,[4] of Hollywood, through a special diet and a calcium formula called "Mineralogen." The cancer cases are problematical, but usually appear for operation with the deficiency from cancer removal rather than from the growth.

FIG. 12.—Flap is reversed, depending on location of deformity.

The request of an old photograph of the patient before the deformity took place serves not only as a psychological stimulant, but as an aid for modeling clay replacement on the plaster cast made of the patient as a basis for reconstruction.

The cast is made with the patient in a recumbent position. United States Gypsum No. 1 plaster is better and cheaper than dental plaster. When the mold is made a glue cast (Fig. 10) should first be made before the final plaster cast. The glue cast (White Glue Composition, Young Novelty Co., of Boston) serves as an actual model which can be sutured, using thin leather for the flap after measurements have been determined from the modeled nose on the plaster cast. Ivy[5] following Blair's suggestion, presented a suggested set of measurements for the average flap which may be modified to suit. Smith[6] in a late book presents a similar schematic flap with plan for figuring measurements. Smith is also responsible for an important axiom that "reconstructive surgery is one field of endeavor in which procrastination is not a thief of time."

FIG. 13.—Flap outlined. Arrows demonstrate blood supply. Nasal, frontal and anterior temporal arteries.

First Stage.—Once the style and size of the flap having been determined by actual planning on the glue model a tinfoil pattern is worked from the leather flap and traced (methyl-violet 5 per cent. in alcohol) on the forehead. Due regard is paid to blood and nerve supply (Fig. 13) in that the nasal, frontal and anterior temporal arteries are preserved to supply the base. The flap is now incised under local or general anæsthesia, care being taken not to cut through the frontal or temporal muscles. The anterior temporal artery at the distal

FIG. 14.—Flap raised and rolled back to allow planting of Wolfe (or Thiersch) graft.

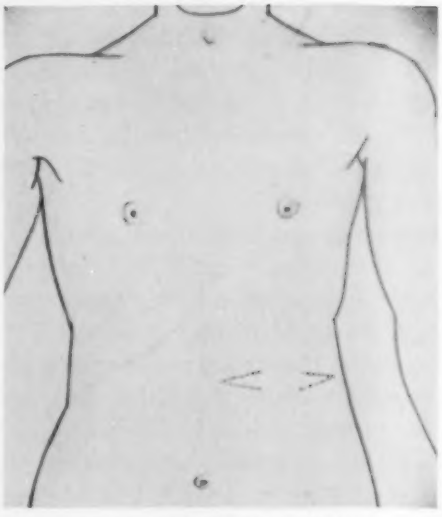

FIG. 15.—Extra closing incisions for lining graft plotted on abdomen.

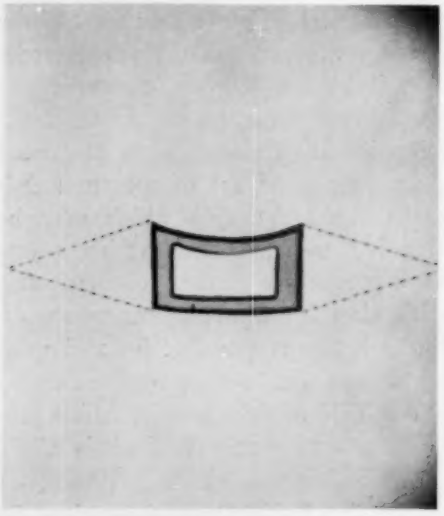

FIG. 16.—Graft when cut shrinks on sectioning. Dotted lines indicate additional tissue to be removed to insure closure. Graft when removed is placed cut side up on pith wood board and stretched to normal size with counter sunk pins at edges. It is then cut down to desired thickness with sharp curved scissors or large scalpel. Graft should be kept warm and dry until ready to plant under flap. If large and thick graft, perforating will aid viability.

FIG. 17.—Same as previous cases. Ten to fourteen days after first stage operation. Wolfe graft has been inserted under flap which has been elevated and resewn.

FIG. 18.—Wolfe graft inserted and flap resewn. Note necrosis distal end of flap due to hematoma from cut anterior temporal artery. An allowance for such contingency is usually made in the original planning of the flap.

FIG. 19.—Flap has been sectioned completely, but only part necessary for insertion of Wolfe graft elevated. Xeroform gauze inserted for aeration of flap and graft.

FIG. 20.—Graft when cut shrinks to half size. Should have all fat and subcutaneous substance removed before suturing to clean dry surface. Note that epithelial side is down.

FIG. 21.—Flap and graft have grown together and are ready to be returned to nasal aperture.

portion of the flap may or may not be sectioned at the discretion of the operator.

Various men differ, some advocating waiting four to seven days, others section the anterior temporal artery at once. The problem is purely one of the length, size and condition of the flap and the size and position of the lining graft to be inserted.

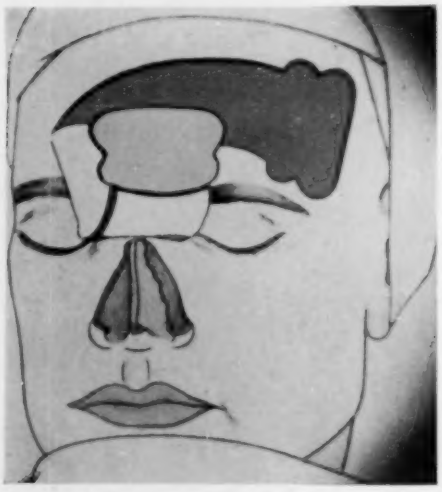

FIG. 22.—Note graft adherent to flap with epithelial side out to form lining of nose.

Practically all authorities at the present writing are unanimous in agreeing that the delayed flap as suggested by Blair [7] is the method of choice and, accordingly, the flap after elevation (Fig. 14) is resewn to the forehead for a period of seven to twenty-one days.

The problem of lining the nose is of as much importance as is the supplying of a covering flap. While the lining does not take on the physiological functions of the missing mucous membrane, it, however, greatly prevents contracture and supplies early healing. The question of a lining, whether of Thiersch or Wolfe graft, for the upper portion of the nose not taken care of by the infolding of the distal portion of the flap to form the necessary alæ and columellæ, is entirely one of supplying the deficiency thickness. If a good amount of septum is present along with available alar tissue and columella, a Thiersch graft lining of the flap will supply the need. If the nasal tissue is totally gone or unfit for use, a thick full-thickness graft from the abdomen (Figs. 15 and 16) grown to the flap will give several millimetres raise in the final result and supply necessary strength to build a new columella and ala nasæ. The general background of the patient may be such as to make advisable only the outlining of the flap—omitting incision of the anterior temporal artery and elevating only the portion of the flap necessary to insert the graft for lining. (Fig. 19.) Conservatism during the first stage of rhinoplasty when suggested by surgical judgment usually pays accrued dividends.

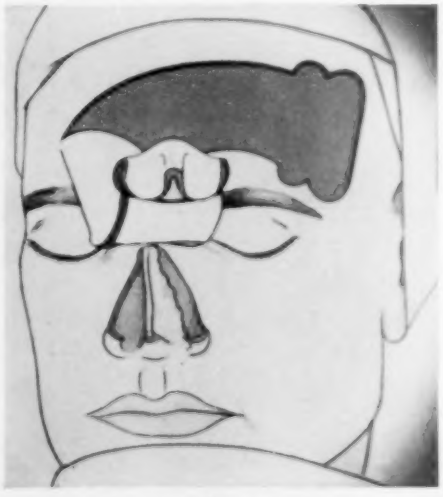

FIG. 23.—Distal portion of flap folds to form columella and ala nasi.

A free full-thickness graft (Fig. 20), used for lining, is best protected from failure by careful expression of any blood clots between it and the

flap. Small rubber drains removed in twenty-four to forty-eight hours if hemostasis is not satisfactory are advisable. The flap, including graft (Fig. 21), is resutured to the forehead with No. 7 black, twisted, paraffined silk, which passes through the flap, graft and forehead skin. It is then dressed with 3 per cent. xeroform ointment and sea sponge moderate pressure for five to seven days. At the same time the forehead flap is prepared, the necessary work on the nose such as removal of old crusts, infected areas, scar tissue, and excess nasal arch is done. A proper columellar base is assured, utilizing some of the upper lip if necessary as the new columella of the flap must have a secure anchorage. It is also important that the airways be subjected to such measures as will insure their functioning properly following the second stage.

FIG. 24.—Tube down forming new columella and ala nasi. Note Wolfe graft on forehead to supply tissue left for nose.

Second Stage.—Seven to fourteen days later (with thirty as a maximum), the graft having taken, the flap is again elevated and brought down over the nasal area. (Fig. 22.) The aperture edges are sectioned at right angles and undercut sufficiently to prevent inversion of the scar. The columella and ala nasæ are formed (Fig. 23) and sutured with catgut. The flap is first attached at the glabella and then with interrupted sutures to the aperture. No effort need be made toward tubing as it will tube itself in a few days. Hæmorrhage from the tip of the flap during operation is an aid to preventing congestion and an index of viability.

FIG. 25.—Note amount of profile deficiency supplied by tube.

Hemostasis throughout is best controlled by pressure and hemostats rather than sutures, especially in the line of union. Rubber nasal splints are inserted and changed as necessary to give open air passages and keep alæ dilated. The forehead skin deficiency may be supplied by a free full-thick-

FIG. 26.—Frontal view of same case as Fig. 25. Forehead is free granulating surface.

FIG. 27.—Flap is sectioned at proximal portion of lining of flap.

FIG. 28.—Flap has tubed itself and is considerably shrunk.

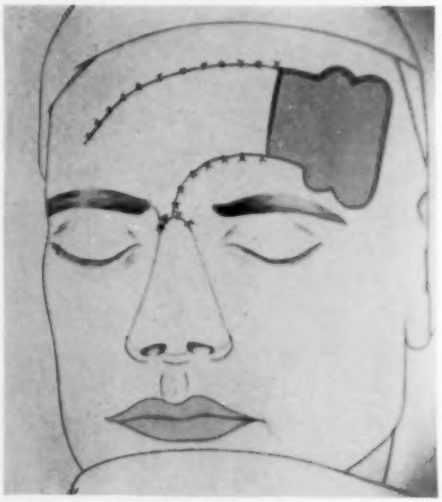

FIG. 29.—Flap extended and sutured.

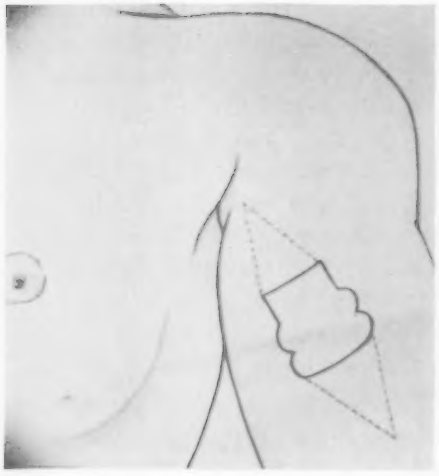

FIG. 30.—Forehead defect is plotted on inner side of arm.

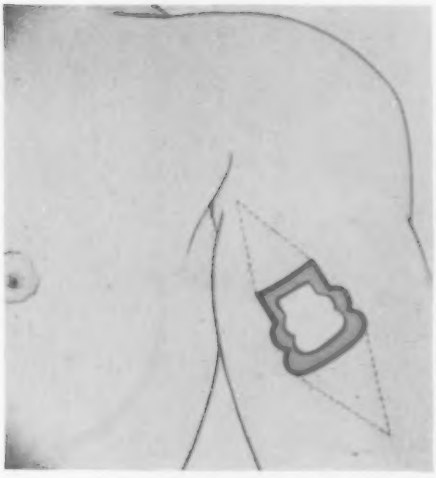

FIG. 31.—Note shrinkage of graft on sectioning.

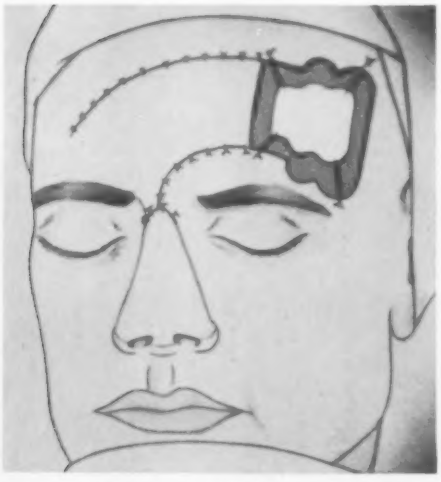

FIG. 32.—Wolfe graft from arm on forehead. Epithelial side out.

FIG. 33.—Graft stretched to normal and sutured.

FIG. 34.—Ninety days following first stage. Same case as Fig. 1.

ness graft from the abdomen, arm, or thigh. If deemed better a small Wolfe graft, sized to fit the amount of tissue used on the nose, may be inserted in the forehead wound and the flap, when returned, sutured to it. (Fig. 24.) In cases where further plastic work is planned shortly after the return of the flap, the forehead may be allowed to granulate in and grafted at that time.

The tube while down must be watched carefully. It should be dressed daily and any small foci of infection dealt with promptly. Sutures are removed in from one to three days. A strip of vaseline or xeroform gauze is usually all that is necessary for a protective dressing.

Third Stage.—After fourteen to twenty-one days the tube is severed (Fig. 27) and returned to the forehead. (Figs. 28 and 29.) The upper nose is then sutured to fit. Perforated nasal splints are kept in the nose for several weeks, day and night, and then only at night for a month's time.

The Wolfe graft for the forehead is best taken from the soft hairless skin of the inner surface of the arm (Fig. 30), thigh, or abdomen. It is cut exactly to fit the forehead defect and dressed with xeroform gauze and sea sponge pressure, approximating twenty to thirty millimetres of mercury for five to ten days. Sutures are removed as necessary. Those showing pressure necrosis or looseness are removed at once.

Cartilage may be used to replace the septum deficiency if too pronounced a saddle nose results once repair is complete. However, it is best used after contracture is complete and swelling has disappeared.

FIG. 35.

COMMENT

The problem of total rhinoplasty then resolves itself at present into the acceptance of the Nelaton-Blair forehead flap method. The use of plaster and glue casts is advisable. The lining of the new nose is supplied by Thiersch or Wolfe grafts grown to the portion of the delayed forehead flap

FIG. 36.—One hundred and twenty days following first stage. Same as Fig. 2.

FIG. 37.—No cartilage has been used in either case. Figs. 34 or 36.

designed to cover the proximal part of the nasal deficiency. The alæ and columella are formed by infolding the distal portion of the flap. An ability to wait between stages until a blood supply sufficient for the next stage is assured is a virtue to be cultivated.

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RESTORATION OF THE SUB-SEPTAL PORTION OF THE NOSE

By Wladyslaw Dobrzaniecki, M.D.

of Lwów, Poland

From the Surgical Clinic of the University of Lwów, Prof. H. Schramm, Director

Destruction of the sub-septal portion of the nose may affect its cutaneo-membranous or its cartilaginous structure. Lesions of these parts may exist by themselves or may be connected with other lesions of the lower part of the nose. The lesions in question, however, commonly constitute deformities due to tuberculosis or syphilis. The form of tuberculosis usually producing these lesions is lupus, which simultaneously affects the sub-septal region and the alæ nasæ and may more or less affect the upper lip. Syphilitic destruction is more profound and may involve the entire osteo-cartilaginous structure of the part.

Fig. 1.—Loss of nasal septum. Before operation.

Several operative procedures are available for restoration of the sub-septal region. All are based upon three essential methods, the Indian, Italian and French, which employ plastic use of tissue for replacing the deficient substance. A chronological study of the reparative methods in question shows that both the older and the modern operators prefer to use flaps taken from the immediate vicinity of the affected part, and usually from the upper lip. The method of obtaining material from parts distant from the lesion has been abandoned, on account of the extent of operation required and the large scars thus produced, out of proportion to the area repaired.

In the Indian method, Dieffenbach employed a frontal flap, with superior pedicle, attaching its apex by an incision made in the upper lip. This method has been quite rejected. In utilizing the Italian procedure, Ch. Nélaton repaired the sub-septal area by using a flap taken from the antero-internal surface of the arm. Labat obtained skin from the thenar eminence of the left hand.

Most of the modifications have been introduced by the French method, which employs tissue taken from the near-by parts. Serre obtained a flap from that part of the upper lip corresponding to the naso-labial groove. Blandin resorted to the same region, but used the entire thickness of the lip, leaving the pedicle superior, so that, after fixation of the flap to the lobule of the nose, the mucosa of the lip was turned below and outward. Lexer employed the mucosa itself, which was introduced by an incision made in

the upper border of the naso-labial groove. Dupuytren, Dieffenbach and Nicoladoni employed cutaneous flaps from the upper lip which were horizontal or oblique below. Szymanowski and Dieffenbach applied flaps taken from the back, or ridge, of the nose. Raoult and Demons used two lip-flaps, and Payr employed two flaps taken from the naso-genian folds. Lossen and Mikulicz took their flaps from the borders of the alæ nasæ in special cases.

Any of these methods may be practiced, provided the defect in the sub-septal region include only its cutaneous and membranous portion. With more extensive lesions, flaps taken from the soft parts themselves are insufficient, because the consequent retraction deforms the lobule of the nose. For this reason, the repaired sub-septal region is supplied, in suitable cases, with more effective support, formed from bone or cartilage. With this object in view, Hildebrant formed an osteo-plastic frontal flap, conducting it through the nasal cavity by means of an incision made in the ridge of the nose. Hacker advises a bony fragment taken from the excavated border of the piriform orifice. Joseph obtains an osteo-periosteal graft from the tibia, inserted into the upper lip before it is severed. For the same purpose, he employs cartilage taken from one rib, or from the auricle of the ear. In special cases, he even takes cartilage from the alæ nasæ, in a procedure which he calls rhinometathesis. Plastic methods of this kind have also utilized the phalanges of the little finger (Leischner) or second toe, at first grafted into the palm of the left hand and used later for filling the defect in the sub-septal region, after the Italian method. Removal of the nail before operation is evidently necessary. Attempts at homo-plastic treatment resulted in complete failure (Leischner).

FIG. 2.—After operation.

Frangenheim used the lower border of the quadrangular cartilage with posterior pedicle covered, because of lesions present, with fully healed mucosa imitating the normal skin. In another case, he used the vomer, which was trimmed suitably and lowered to the anterior nasal spine.

In our case, presenting a total loss of the mobile part of the sub-septal region and a partial defect in the cartilaginous and bony structure of the part, we used a combined method, taking a posterior flap from the mucosa of the upper lip, to constitute two-thirds of the sub-septal region, and an anterior flap from the skin of the vestibule of the nose, to repair the remaining third of the defect. In order to provide effective support for the repaired part and prevent retractile deformity of the lobule of the nose, we implanted a cartilaginous plate taken from a rib. Following we give the details of the procedure.

Operation was begun by instituting local anæsthesia at considerable distance from the site of operation, in order that the œdema accompanying the anæsthesia might not produce deformity at the operative site. A rather large flap was then taken from the mucosa of the upper lip, extending only to its ruddy portion, its pedicle extending in width one centimeter on each side of the little central ridge leading to the vestibule of the nose. The free apex of the flap was introduced through an incision across the naso-labial furrow. Since the flap itself was too short and would cause deformity after suturing it to the lobule of the nose, we took an anterior flap, mentioned above, from the skin of the vestibule of the nose. This flap was so taken that its pedicle lay beneath the protuberance of the nasal lobule, the final position of the epidermal surface becoming external and turned below, while its raw surface lay above and interiorly, like the remainder of the posterior flap. The two flaps were united at the site of contact by a few sutures of silk.

Into the sub-septal region, thus repaired, was now introduced a cartilage fragment taken from the seventh right rib. The graft must be removed without involving the entire thickness of the costal cartilage. This precaution permits avoidance of bleeding and risk of injuring the peritoneum.

In such cases as these, we always prefer cartilaginous grafts because they possess almost no blood vessels and are thus already accustomed normally to imperfect nutrition. In this way, success of the grafting is much facilitated. Again, cartilage is eminently suitable for plastic uses. It is easily shaped, may be perfectly modelled and becomes infected with greater difficulty than is the case with bone. Bony grafts, as we have found by studying our clinical material, is likely to be resorbed after a year if it is not placed in tissue resembling that of its original site, and depends upon the size of the graft more than do cartilaginous grafts.

The wound was healed, and the sutures were removed, in twelve days after operation. In the post-operative treatment, it is very important to remove the free secretion by means of inhalations and the use of a protective ointment.

Opinions of various writers differ concerning the behavior of the mucous membrane, which is exposed to immediate contact with the air and constitutes two-thirds of the sub-septal region when the latter is repaired, as in our case. Some think that the mucosa, when thus exposed to external agencies, becomes converted into skin, as observed sometimes in rectal or uterine prolapse. Rollet states that the mucosa forming the external aspect of the flap becomes gangrenous in four days after operation, sloughs off, and leaves the surface of the mucosa to heal by granulation. Others, such as Sédillot, Nélaton and Ombrédanne, believe that the mucosa undergoes no process of epidermization essentially but that it remains thin and rosy and is constantly covered by exfoliating particles which are continually renewed.

In closing, we may state that the mucosa, as occurring in our case, assumes the character of skin in time. Only at the outset is it covered by free secre-

tion and exfoliation, due to irritation and to the changes in environmental conditions which it encounters. We have noticed similar changes in the mucosa, accompanying prolapse of the vagina. Under abnormal conditions, the mucosa doubtless undergoes metaplasia. The influence of external agents is well known for its ability to induce metaplasia, as for example, in pigmentation of the skin, ossifying myositis, and conditions of analogous character.

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PARATHYROIDECTOMY FOR ANKYLOSING POLYARTHRITIS*

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Of the many pathologic conditions affecting the spinal column, two have been recognized for many years: one, described by Bektereff, termed "stiffness or rigidity of the spine" and the other called by P. Marie "spondylose rhysomélique." These conditions have been described in literature, being respectively termed Bektereff's disease and Strumpel-Marie's disease. The symptom-complex of the two conditions considered differs in that in Bektereff's disease there is to be noted a bow-shaped kyphosis of the entire spinal column, while in Marie's disease the spine is fixed and erect, usually with an accompanying involvement of the hip- or shoulder-joints. In the case of the former, there is merely a stiffness and rigidity of the spine, while in the latter there is a definite ankylosis, not only of the spine, but of the big joints of the extremities. On careful investigation, the difference between these conditions is a question, apparently, of degree only. This was pointed out by Turner of Leningrad after having studied many preparations of bones he had acquired following the deaths of patients suffering from these conditions. He was able to demonstrate conclusively that if prolonged enough the condition described by Bektereff finally ended in an ankylosis of the spine. Various combinations of stiffness and partial immobility in both the spine, hip, shoulder-joints and ribs have been noted by many observers. Indeed some of the cases I have observed have gone so far as to have complete involvement of all joints of the body. Therefore, the difference between the two conditions is quantitative rather than qualitative. Before reaching the final stage described by Marie they all pass through the stages first of interference with mobility on to complete immobility and finally ankylosis. It is, therefore, suggested that in referring to these conditions a term be used to cover both, such as ankylosing polyarthritis.

It appears evident to me from observations that the kyphosis spoken of by Bektereff is a distortion of the spine, due to the fact that the patient suffering from this condition is still able to walk and work, and that the spine takes this curvature due to the weight of head and shoulders. If, however, the patient is incapacitated and lies in bed continuously, the spinal column becomes ankylosed in a straight or erect position. In three cases under my personal observation, who were apparently suffering from Bektereff's disease with kyphosis and were put to bed and treated orthopædically under an anæsthetic, the spinal columns were straightened and plaster-of-Paris cases applied for two to three months. When removed, the spines were ankylosed

* Translated from the Russian by A. S. Kasatchenko, M.D., of Montreal, Canada. Read before the IX Congress of Physicians at Quebec, Canada.

in a straight position with a similar ankylosis of the hip-joints which had also been encased in the plaster.

Of these patients who have developed ankylosing polyarthritis, one is as a rule able to obtain a history of an infectional process such as scarlet fever, typhoid, spotted fever, acute suppurating osteomyelitis or gonorrhœa, which conditions have immediately preceded the subsequent affection of the spine and of the other joints. It is interesting to note that although these conditions are apparently an infection of the joint following acute inflammatory conditions, sometimes chronic, suppuration does not develop and cause localized joint abscesses but merely terminates in an ankylosis of the affected joint. Puzzling also is the explanation of why some of the patients so affected have their joints finally ankylosed while others do not have this condition occur.

Doctor Belsgorodsky in making detailed and analytical examinations of his patients suffering from ankylosing polyarthritis discovered in all of them an increase of the calcium content of the blood, while Doctor Schraer noted that ordinarily such patients had a reduced electro-excitation of the muscles and Doctor Demidovskaya stated that he had noted in many an increased viscosity of the blood. In the recent data supplied by Doctor Samarin he noted that in 26 patients, whose blood had been examined, 19 showed a lymphocytosis as high as 50 per cent.; of 14 patients examined, 11 showed an increased viscosity of the blood, using the apparatus of Litchikowsky, based upon the time of 5 seconds as normal. In these cases it frequently reached 6 to 7 seconds. On the basis of 4 milliamperes electro-excitation, out of 22 patients, there were 19 who showed a reduction from 5 to 10 milliamperes. In 42 patients in which the calcium content of the serum was determined, 28 showed a definite hypercalcæmia, while 14 had a normal calcium level. Assuming between 9 and 11 milligrams of calcium as the normal, the contents of these varied from between 6 and 15 milligrams per cent.; out of 29 cases in whom the potassium content was investigated, 7 cases showed it increased (from 29 to 37 milligrams per cent. and in 3 cases it was lowered (from 13 to 16 milligrams per cent.). In the remaining, it was normal, indicating that there was no sharp change in the level of the potassium. Finally it was noted by Nekrasoff that the inorganic phosphorus was apparently increased while the organic phosphorus was normal or but slightly increased, assuming 2.8 milligrams per cent. of inorganic phosphorus to be normal, while the average percentage in these cases examined was 3.43.

Therefore, it is to be noted that there is (1) an increase of the level of calcium in the blood, (2) a decrease of electro-excitation of muscles, which findings are just the opposite of those in tetanus in which the calcium level is lowered and the electro-excitation of muscles increased. In tetanus, one notes cramps while in polyarthritis there is a restriction or tightness or stiffness on motion. If we consider tetanus as an expression of hypofunction of the epithelial bodies, then all of the above-mentioned findings in cases of ankylosing polyarthritis would incline us to infer that we are dealing with a hyperfunction of the epithelial bodies. What called my attention more par-

ticularly to the hyperfunction in these cases was the apparent deposit of excessive calcium formation at the foci of inflammation or in diseased joints, and because of the presence of which the inflamed joints pass into a stage of ankylosis after the preliminary stiffness.

Correlating the work of Collip, who showed that the hormone of the parathyroid bodies increased the level of calcium in the blood, with the findings in cases of ankylosing polyarthritis, it appeared evident that my theory of hyperparathyreosis received material support and that, theoretically, this condition is instituted through the infections preceding the development of the joint conditions developing in certain persons possessing a predisposition or constitutional tendency to hyperparathyreosis.

Therefore it appeared to me a logical reasoning that in order to prevent the development of ankylosis or to eliminate preliminary stiffness, it was essential to diminish the hypercalcæmia by destroying a part of the epithelial bodies which were causing this condition in the blood, which, as indicated, appears to originate in the parathyroids.

The operation is, as a rule, ordinarily done under local anæsthesia, incision being made along the front edge of the right sternocleidomastoid muscle. The inferior thyroid artery is first identified and the parathyroids searched for where the inferior thyroid artery enters the thyroid body. There is, as a rule, a lower, small gland and an upper one. In order to be more certain of their removal, the capsule is incised and a portion of the right thyroid gland resected. In some instances, it is to be noted that the parathyroid is incorporated in the substances of the thyroid gland itself, which is at times evidenced in the development of a parathyroid growth in the substance of the thyroid gland (Craft). The microscopical verification of the excised parathyroid bodies shows how difficult it is to recognize them and how difficult and delicate a parathyroidectomy is. We have operated on fifty-five patients. In thirty-three of these cases, Doctor Samarin made microscopical examinations of the tissue removed. In ten cases no parathyroid tissue was found, although in these examinations a complete serial section was not made. Out of the twenty-one patients in which the parathyroid bodies were found to be present, it was noted in only two instances that two parathyroid glands had been extirpated. While it must be evident how important it is to receive a microscopical criterium of the removal of these epithelial bodies, we are also most interested in the resultant chemical change in the blood. This examination should be done within two weeks after the operation but after recovery from any shock which might have been caused by the operation itself. Out of thirty investigations, twenty-seven showed that the postoperative calcium level was in some instances reduced to 1–3 milligrams per cent. Therefore it would appear that the chemical criterium was more illuminating than the microscopical. In addition also, the chemical examination of the blood confirms the fact that in some instances the epithelial bodies were not removed at operation.

The results of the above procedure have been most interesting. As already

mentioned, these diseased joints go through a stage of stiffness or interference with their mobility, the patient being conscious of a feeling of distress in them and of some limitation of motion. While parathyroidectomy cannot alter the already formed ankyloses, which for their correction require mobilization, still it is advisable to precede such mobilization with parathyroidectomy in order that after manipulation there will not be a predisposition on the part of the patient again to deposit lime in the joint.

Sometimes the most striking effect resulting from this operation is that as early as twenty-six hours after parathyroidectomy this sensation of stiffness has been noted to disappear from one joint after another. If it has affected the shoulders and it is difficult for the patient to lift his arms, they are thereafter easily moved and the patient describes the joint as having become much looser. Even joints with which there was extreme difficulty in motion become progressively and sometimes completely movable. In the hip-joint where it has been impossible for the patient to cross his legs, postoperatively he does it easily. Those with the stiffened spinal columns increase in stature several centimetres because of their ability to make the columns more erect.

Samarin, in summarizing the results in forty-nine cases following parathyroidectomy found no improvement in sixteen and improvement in thirty-three cases. If one takes into consideration the fact that in ankylosing polyarthritis the patient in all probability cannot be cured and has effected only a moderate improvement on the employment of thermal baths, the results of this operation may be considered very encouraging, for it primarily destroys the hypercalcæmia, thereby stopping the process of progressive ankylosis, and this is indeed the most important principle to be effected by the operation. It seems evident, in addition, that the reduction of the hypercalcæmia in some way influences beneficially the function of the voluntary muscles, giving them greater freedom of movement. While the already formed ankyloses remain, it evidently improves the partially immobilized spine without, however, completely straightening it. It is interesting to note, in addition, that in these cases, the muscles of the back show a definite stage of acute atrophy while, on the contrary, those in the front of the body are in the stage of habitual contracture.

These patients require much additional attention after the extirpation of the parathyroids. Primarily in cases of multiple ankylosis of joints, mobilization is indicated. Orthopædic treatment is essential to overcome the atrophy of the back muscles and to cause the resumption of the erect posture of the spine.

It is, therefore, my desire thus to place before the profession what seems to me to be the ætiologic factor in these cases of ankylosis and a procedure which not only appears to be remedial for the stiffness and consciousness of discomfort and immobility of joints but also a method of preventing further ankylosis in cases of ankylosing polyarthritis.

DIRECT AND INDIRECT INJURY TO THE RECURRENT LARYNGEAL NERVES DURING THYROIDECTOMY*

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Perhaps one of the most common complications in operations on the thyroid gland is injury to one or both recurrent laryngeal nerves. During the last few years considerable attention has been directed to the prevention of this complication, which, it is believed, is fairly common and perhaps not infrequently unrecognized.

New and many others believe that injury to one or both recurrent laryngeal nerves occurs much more frequently than most persons believe. A careful survey would lead one to accept this assumption as just and true. Most injuries to the recurrent laryngeal nerves probably occur because of unfamiliarity of surgeons with their anatomic position, which is different from what the average textbook pictures.

Mikulicz emphasized the importance of leaving a small amount of thyroid tissue on the lateral wall of the trachea, along the course of the nerve, to prevent injury to it. Before his suggestion, Billroth reported partial or complete vocal cord paralysis in 32 per cent. of a series of seventy-one cases of thyroidectomy done by Wölfler. By a statistical study, Jankowski found paralysis of the cord in 14 per cent. of cases of extirpation of the thyroid gland. Following the plan of Mikulicz, Roux, in 1894, was able to do thyroidectomy 100 times without objective evidence of injury to a single nerve. Later, Kocher, in a series of 900 operations of thyroidectomy, thought his injuries to nerves amounted to 7 per cent.

It seems reasonable to assume that the most common sites of injury to the recurrent nerves during thyroidectomy are at the inferior pole of the gland, along the lateral surface of the trachea, and at the cricothyroid juncture where the nerve pierces the larynx. If a small amount of glandular tissue is preserved at the inferior pole, injury to the nerve is not likely at this point. If too much of the gland is resected along the lateral surface of the trachea and at the cricothyroid juncture, and if, also, suturing is necessary to effect hemostasis, injury to the nerve is likely. It is extremely important, in cases in which general anæsthesia is used in addition to local anæsthesia, that the patient be allowed to waken after the extirpation of one lobe, in order that the operator can determine whether or not there has been injury to a nerve.

In most instances injury to one recurrent nerve, of a sort that will be permanent, gives the patient little trouble immediately after operation, and the voice usually approaches normal in two or three months. If severe

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tracheitis occurs in a case with injury to a single nerve, respiratory embarrassment may be marked for two or three days.

In many cases in which there has been injury to the nerve of one side, post-operative œdema of the glottis is also present and the breathing space consequently will be narrowed; the laryngoscopic picture may be similar to that of bilateral nerve injury, but one vocal cord will be seen to move on respiration and the movement will be only slightly impaired by the œdema.

Occasionally symptoms of impairment of the nerve supply develop a day or two following thyroidectomy, even though objectively during and immediately following operation, the function of the larynx apparently was normal. In a few of these patients it was possible to demonstrate, by laryngoscopic examination, impairment of the function of one or both recurrent laryngeal nerves. Constant care is exercised in doing thyroidectomy to avoid injury to the recurrent laryngeal nerves and also, in this type of case, there is improvement or complete restoration of function in two or three weeks. New has held for years and has shown clinically that temporary paralysis of the vocal cords following thyroidectomy may be caused by hæmorrhage or œdema about the nerve. In this type of case the paralysis of the cords usually clears up in about two weeks. Laryngoscopic examinations are made before, immediately after and every few days following thyroidectomy in order to observe the changes in the cords. The following case is illustrative of just such injury to the nerve:

Report of a Case.—A man, aged thirty-three years, registered at the clinic June 11, 1928, complaining of weakness, nervousness and loss of weight. The duration of these symptoms was three months. A diagnosis of exophthalmic goiter was made. The basal metabolic rate was +46. The patient was given compound solution of iodine, ten drops three time a day for eleven days, and at the end of this time subtotal thyroidectomy was done. At operation, each lobe was found to be enlarged to about four times the normal size. Glandular tissue equivalent to about one-fourth of a normal-sized lobe was preserved on either side. The pathologist reported the tissue removed to be that of a diffuse, hypertrophic, parenchymatous thyroid gland.

A laryngoscopic examination of the vocal cords before operation showed them to move normally. Another laryngoscopic examination was made two hours following operation and this did not show evidence of impairment of the recurrent laryngeal nerves. Thirty hours after operation, the patient complained of difficult breathing. There was moderate cyanosis, graded 2. Slight exertion caused definite stridor. Laryngoscopic examination at this time showed both cords fixed in the median line with an estimated 25 per cent. of breathing space remaining. The patient was placed in an oxygen tent, which relieved to some extent the respiratory embarrassment, and the cyanosis disappeared. Hot, moist dressings were constantly applied to the wound. At the end of twelve hours, during which time frequent examinations of the vocal cords were made, there was slight movement of both cords with an increase in breathing space estimated at 40 per cent. Gradual improvement continued. The remainder of the patient's convalescence was without incident, and on the seventh post-operative day he was dismissed from hospital. Examination at this time showed a breathing space of from 50 to 75 per cent. July 2, ten days following operation, both vocal cords moved normally and there was no difficulty in breathing.

Comment.—This case is an example of indirect nerve injury in thyroid-

ectomy and was caused, I believe, by œdema of the nerves or of the tissues in close proximity to the nerves, or by slight hæmorrhage exerting pressure on them.

In two or three other cases in which patients who have undergone thyroidectomy signs like those mentioned have appeared. It was necessary in one case to make a tracheotomy, the opening of which was allowed to close, when, in three weeks, the cords moved normally. There is much evidence to indicate that the type of injury here discussed is not caused by direct injury to the nerves in which degeneration takes place. The observations of Judd, New and Mann were perhaps the most convincing proof of this. They showed by animal experiments that complete and permanent paralysis of the vocal cords followed if the nerve were ligated and the ligature not removed. The same result followed when the nerve was severed and prolonged but not permanent nervous impairment ensued if the nerve was stretched by an instrument or was ligated and the ligature soon was removed.

SUMMARY

Some patients who do not show impairment of the recurrent nerves at the completion of thyroidectomy may suffer from temporary impairment of the nerves through indirect injury. Tracheotomy may be necessary in some of these cases.

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IMMEDIATE AND EVENTUAL FEATURES OF HEALING IN AMPUTATED BONES

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From the Hamann Museum and Anatomical Laboratory of the Western Reserve University

The surgical problem of a limb amputation ideally ends with healing of the operative wound. But even when this fortunate event takes place there is still an orthopedic problem to follow, and all too frequently surgical interference is again necessary.

Enjoying the opportunity afforded by the unique material in the Hamann Museum of this University it appears timely that a comprehensive survey be made of the after-results and complications so far as these reveal themselves in the amputation stumps. The five following general subdivisions at once appear.

1. Gross and detailed features in the healing of bone stumps and the changes in texture of the portion of the limb skeleton remaining.

2. Changes in muscle and weight of the stump itself.

3. The character of, and complications occurring in, the stumps of severed nerves.

4. Clinical developments directly determined by the condition of the stump in the after life of the patient.

5. The lessons to be learned from experimental amputations.

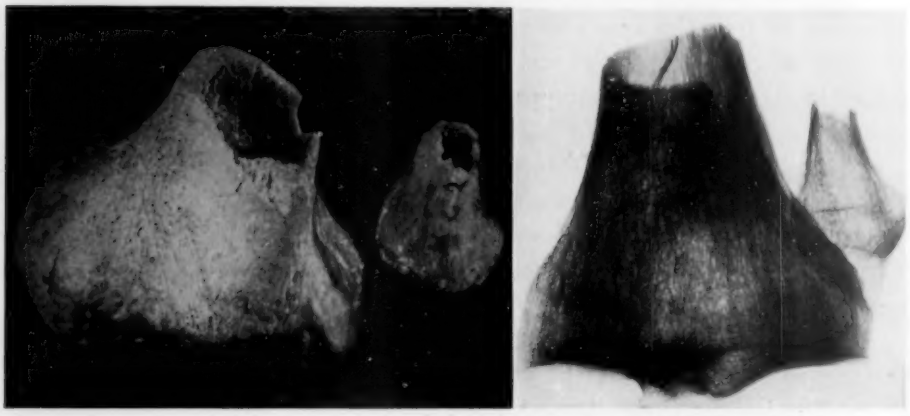
These several subdivisions are not clearly demarcated one from another and it is necessary to include them all for a complete understanding of the problems involved in, and consequent upon, amputation. It is my plan to set forth the results of this study in successive communications. Acknowledgment is due to Western Reserve University for the privilege of investigating the material and for the technical facilities freely put at my disposal for this purpose. I also desire to express my indebtedness to Dr. Wingate Todd for guidance and direction in planning the work and for help in interpretation of my findings. In the experimental work, later to be discussed, I am under a debt of obligation to Dr. H. H. Donaldson of the Wistar Institute, Philadelphia, and especially to Dr. Harold Colson of Flagstaff, Arizona.

In this first communication I propose to discuss the features of healing in the bone stump and the changes later seen in texture of the remaining portion of the amputated bone. Among the 1500 human skeletons at my disposal I found more than forty amputations of the limbs. Six of these I have dissected completely and in all forty I have studied the bony skeleton. Presentation of the findings does not require a description of all

examples. It is better to confine our attention to the features illustrated by particular specimens at successive stages of repair and in later phases of the life history. We shall proceed, therefore, immediately to the discussion of representative examples, paying particular attention at the moment to those features readily noticeable by the naked eye, but also confirming and extending our observations by röntgenographic findings.

THE PHENOMENA OF HEALING

The most recent amputation to which we have access is the right tibia and fibula of No. 262—male, white, about forty years of age. Death was registered as from tuberculosis. The patient obviously sank quickly after operation and soon died and the rough-cut edges of the stumps show indications in their irregularity of haste at operation. So rough and jagged indeed are the edges that one might suspect the specimen to be the result of a post-mortem amputation were it not for the erosion of the bone so



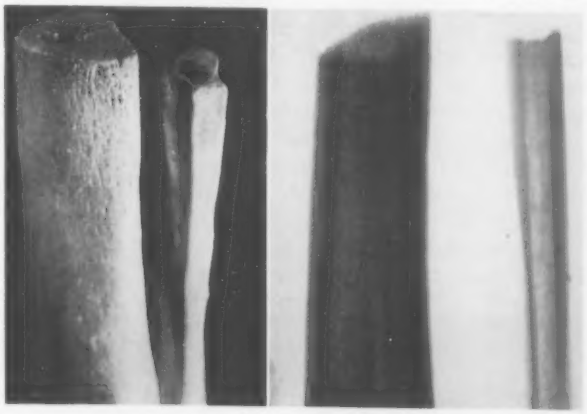
A B

FIG. 1.—Amputation right tibia, fibula. W.R.U. 262. Male, white, about forty years. A—Recent amputation just below tuberosity. Cut edges of bones rough; fissure in subcutaneous surface tibia; no callus. B—Röntgenogram of A. Fissure of tibia identifies lower edge as ventral margin. Entire circumference shows vascular erosion.

evident in the röntgenogram. (Fig. 1.) There is not the slightest indication of surface erosion or of callus formation. Bast, Sullivan and Geist [1] found new bone as slender microscopic spicules as early as the fourth day and absorption of cortical bone on the fifth day. The röntgenographic evidence on this amputation very definitely indicates the earliest stage of reaction. Consequently we may assume that not more than five or six days have elapsed since amputation was performed.

Another very recent amputation in this collection is that of the right tibia and fibula in No. 864—male, Negro, forty-eight years of age. Death occurred from lobar pneumonia which we may consider was post-operative in origin. The operative wound was still unhealed in the cadaver. The amputation severed the bones in their middle third. The cut surfaces were not rounded off at operation: they have sharp edges and the surface, showing plainly the saw marks, is polished as though by a blunt-bladed instrument. There is definitely increased vascularity with accompanying erosion on both bones, especially on the medial and posterior surfaces of the tibia. Indeed on the lateral aspect of the fibula this erosion begins to delimit the line of flake-like sequestrum formation which would ultimately have involved the entire cut surface. Internal callus is evident on both bones but as yet there is no external or surface callus. The features

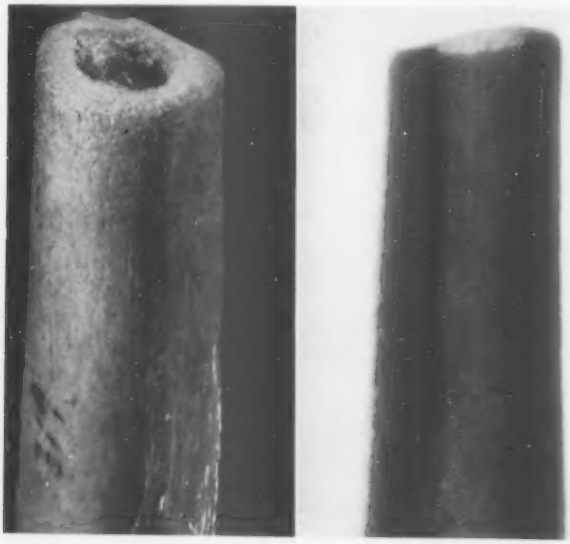
just described would easily escape notice for they are not striking. The röntgenogram, however, clearly shows the pre-repair erosion of both bones adjacent to their cut surfaces. (Fig. 2.)



A B

FIG. 2.—Amputation right tibia, fibula. W.R.U. 864. Male, Negro, forty-eight years. A—Recent amputation middle of shaft. Cut surfaces show saw marks; some increased vascularity; slight internal callus. B—Röntgenogram of A. Well-marked vascular erosion of entire circumference in cortex.

The specimen recalls the femur of No. 156 in the article by Todd and Iler.[2] Now internal callus was observed by Bast, Sullivan and Geist[1] on the fourth day and erosion on the fifth after a saw cut was made on the tibia of rabbits. Erosion rapidly increased in degree during the immediately succeeding days. Actual flake-like sequestra were noted by Todd[3] within three weeks of operative trauma. We may conclude that this specimen No. 864, is from an individual who lived not less than seven days and certainly not twenty-one days after the amputation. The stage of cancellous endosteal callus found in this specimen corresponds with that reached by the rabbits of Bast, Sullivan and Geist,[1] between ten and twelve days after trauma. We may then cite our second case as illustrative of the features to be found in a human bone about eleven days after amputation.



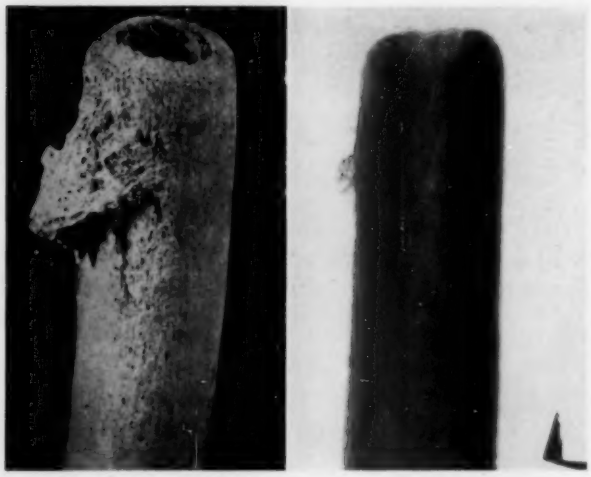
A B

FIG. 3.—Amputation left femur. W.R.U. 319. Male, white, fifty years. A—Recent amputation middle shaft. Vascular erosion of entire circumference with rounding of margin; slight internal callus; some external callus posteriorly. B—Röntgenogram of A. Well-marked vascular erosion; osteoporosis extends upward along shaft.

The next stage in repair of an amputation stump is found in No. 319—male, white, fifty years of age, ill with tuberculosis of the lungs. This specimen is a left femur cut through the middle of the shaft. There is still evidence of recent saw cut in fragmentary remnants of polished flat surface, but for the most part, new vascularity has eroded the entire end of the stump and rounded off its sharp margins. There is internal callus, cancellous in texture, in the most dependant posterior portion of the bone and on the

dorsal aspect there is external callus intimately united with the eroded bone. The röntgenogram (Fig. 3) shows little increase of erosion over No. 864. We may confidently assign this specimen to some thirteen days after surgical interference since the erosion, though well started, is by no means so advanced as found by Todd in the specimen E16, twenty-one days after the onset of osteomyelitis.[2] It is in this specimen that we observe the earliest sign of atrophy, namely clarification of architecture in the upper femur. It is altogether too delicate to reproduce in the röntgenogram and in this specimen it may not represent the permanent atrophy which we shall discuss further on. The cortical bone of the shaft is osteoporotic and this appears as a "moth-eaten" texture in the röntgenogram.

Right femur No. 1585, amputated through the middle of the shaft, was obtained from a male Negro, dying of tuberculosis at the registered age of thirty-one years. There is some reason to believe that this individual was actually about twenty-six years of age. The wound was healed. There was considerable muscular atrophy but the stump was not adherent to the skin. There was enlargement of right inguinal glands following an ulcer of the groin. Erosion of the stump with its consequent rounding of the margin is very clearly seen both on the specimen and on the röntgenogram. (Fig. 4.) No internal callus is to be found and critical examination of the specimen makes it certain that the absence of endosteal callus is genuine and not due to faulty preparation. It is the more remarkable that there should be no callus in the marrow cavity because there is a large mass of external callus on the medial and posterior surfaces firmly united to the underlying bone and already largely converted into a sclerosed cancellous excrescence.



A B

FIG. 4.—Amputation right femur. W.R.U. 1585. Male. Negro, twenty-six years. A—Recent amputation middle shaft. Cut surface shows much vascular erosion and rounding; no internal callus; external callus forming osteophyte. B—Röntgenogram of A. Well-marked erosion of stump with osteoporosis extending up shaft; external callus developing into osteophyte.

We shall have to draw attention to this absence or minimal development of endosteal callus in further specimens reported in this essay; at the moment it is sufficient to record the fact. The lava-like external callus together with the marked erosion identify this specimen as at approximately the stage of fracture as No. 388 in the report by Todd and Iler.[3] On the basis of other features characteristic of fracture, but absent from amputations, these authors assign No. 388 to some seventeen days after injury. We may, therefore, consider our specimen No. 1585 also to illustrate the condition present in an amputated stump about seventeen days after surgical interference.

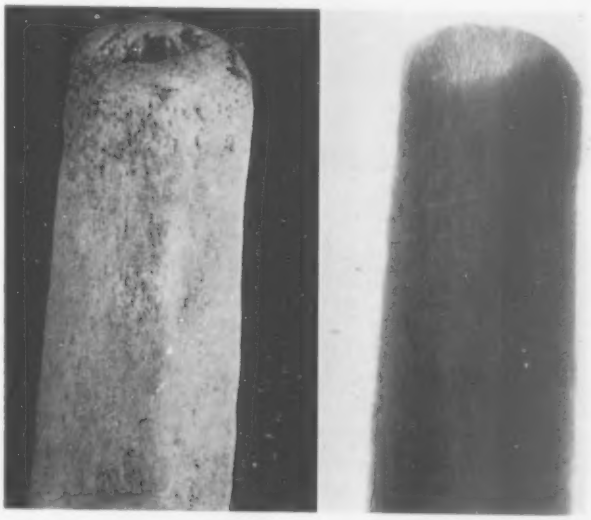
It should be noted that the appearance of external callus in this specimen is quite erratic. But Todd and Iler have already emphasized the

erratic exhibition of bone repair. We see the same character in this amputated stump. It is undoubtedly due to this fact that isolated osteophytic growths are sometimes found in clinical cases.

In the last example reference was made to upward extension of osteoporosis along the shaft with clearing of texture in the upper part of the bone. Both features are much better marked in No. 1585 and their presence suggests that a rapid rarefaction of bone is occurring.

No. 952 is the amputated right femur of a male, white, forty years of age. The patient hanged himself after discharge from hospital. There was no marked atrophy of the stump though it was bluntly conical. The wound was healed.

The amputated surface and adjacent shaft show vascular erosion of considerably closer texture than in the preceding examples. This is plainly due to a healing or condensation of the osteoporosis following the surgical trauma. The margins are rounded. There is no internal callus and we have reason to assume that such internal callus as there ever was has by this stage been absorbed. Remnants of external callus exist as irregularities of the cortical surface. The face of the stump shows an attempt at capping of the medullary cavity by a thin condensed extension of the stump margin brought about apparently through the formation of a kind of definitive callus.



A B

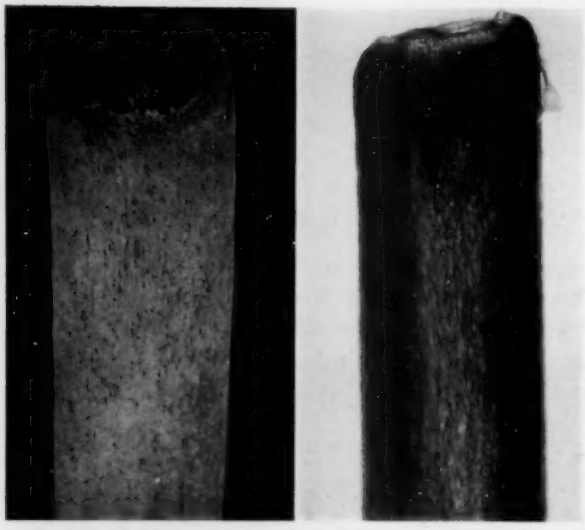
FIG. 5.—Amputation right femur. W.R.U. 952. Male, white, forty years. A—Amputation through middle of shaft, not many weeks previously. Texture of stump is condensed and characteristic of a healed bone. Stump rounded. Very inadequate attempt to form cap of bone closing marrow cavity. B—Röntgenogram of A. The erosion of the bone end is obscured by healing or condensation; attempt at capping of medullary canal too feeble to be apparent.

The röntgenogram (Fig. 5) shows a healed vascularity of closer texture than in previous röntgenograms. It also demonstrates osteoporosis of the shaft and atrophic texture of the upper end of the femur. The appearance of the bone strongly suggests a lapse of time after amputation comparable to healed fracture No. 453 in Todd and Iler's[2] communication. The only statement these authors would hazard is that "not many months" had elapsed. And with this we must also be content though we should prefer the phrase "not many weeks."

THE ULTIMATE FEATURES

The next stage in healing is illustrated by No. 1519—the left femur of a male, white, seventy-one years of age, amputated in the lower third. The patient was stated to suffer from chronic interstitial nephritis and senile dementia. The bone shows typical atrophic textures of senility and the cadaver itself showed a conical but not a pointed stump. There is no doubt that amputation had occurred many years previously.

An attempt to close the marrow cavity has resulted in the formation of a thin condensed cap of fenestrated bone with no narrowing or filling in of the marrow cavity



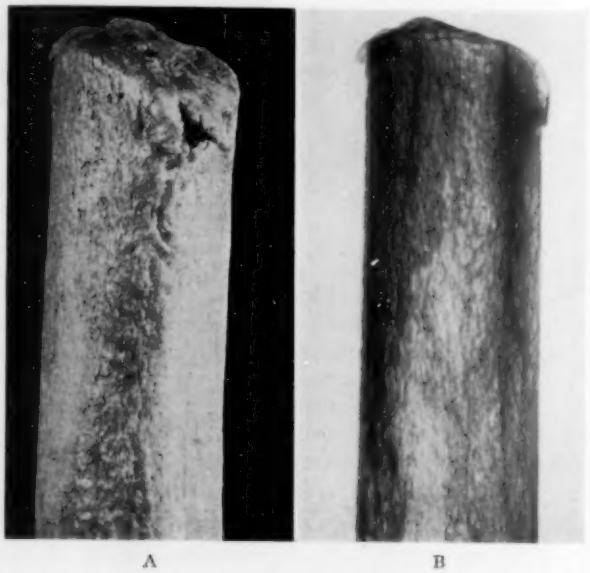
A B

FIG. 6.—Amputation left femur. W.R.U. 1519. Male, white, seventy-one years. A—Amputation of long standing, through lower shaft. General osteoporosis of shaft quiescent in type with rounding of stump and fenestrated cap of bone closing medullary cavity. B—Röntgenogram of A. General osteoporosis without moth-eaten surface such as appears in more recent examples. Dark shadow of condensed and quiescent bone in cap. Irregularity due to dorsal osteophytes.

and but slight dorsal osteophytic formation. There is typical rounding and atrophic texture of the stump such as we find in all old amputations. (Fig. 6.)

The röntgenogram shows osteoporosis throughout the shaft, it is true, but this is quite inactive. It is uniform and free from the moth-eaten texture of the shaft surface such as we saw in the foregoing specimens. The dark shadow of condensed bone in the cap is characteristic of a long-healed and quiescent stump.

No. 1217 is the right femur of a male, white, fifty-nine years of age, dying from cerebrospinal syphilis according to the clinical diagnosis. The amputation again is of long standing and the entire bone is osteoporotic and quiescent. The marrow cavity is closed by a condensed thin, but complete, cap of bone. There is but the slightest osteophytic development. (Fig. 7.) The röntgenogram corresponds with the above findings. Indeed this may be considered as a perfect technical result and illustrates for us the ideal attainable termination in stump formation. There is no evidence that with the passage of years this bone has become progressively atrophic, a consideration sufficiently significant from the point of view of treatment.



A B

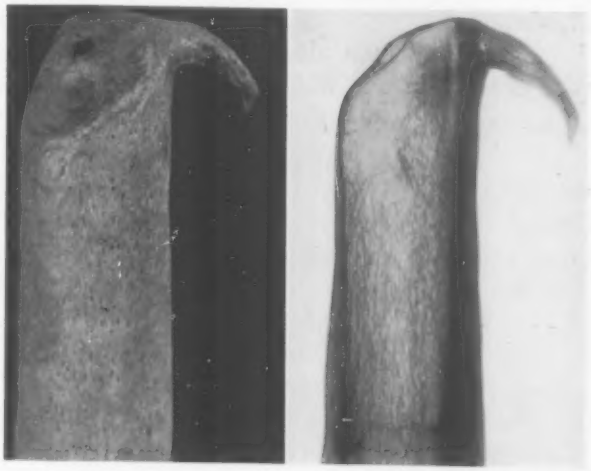
FIG. 7.—Amputation right femur. W.R.U. 1217. Male, white, fifty-nine years. A—Amputation of long standing, through upper shaft. Ideal technical result. Quiescent osteoporotic shaft. Complete condensed cap. Negligible osteophytes. B—Röntgenogram of A. Osteoporosis without moth-eaten surface. Dense shadow of cap.

The last of the series we desire to present is No. 1332, an old amputation through the middle of the shaft of the left femur in a male, white, about forty-two years of age. The cadaver showed an excellent stump except for an osteophyte projecting into the soft tissues on the medial aspect of the thigh. Death occurred from suicide by hanging.

The femur, apart from the osteophyte (Fig. 8), shows an excellent result. The stump is rounded, the marrow cavity practically closed by a condensed thin cap of bone. The shaft is osteoporotic indeed, but plainly quiescent. These conclusions are confirmed by the röntgenogram.

As a final problem we may ask ourselves to what good purpose can the tendency of all stumps to form osteophytes be put.

This is well illustrated in our Fig. 9, the amputated right tibia and fibula of No. 1291, male Negro, forty-two years of age, in whom death occurred from tuberculosis of the lungs. The amputation is of long standing. The osteoporotic shafts are quite quiescent, the medullary caps complete and the osteophyte unites the two bones. Our röntgenogram illustrates the perfect technical result and shows specially well the condensed bone of the medullary cap.



A B

FIG. 8.—Amputation left femur. W.R.U. 1332. Male, white, about forty-two years. A—Amputation through middle of shaft. Rounded stump. Quiescent osteoporotic shaft. Practically capped medullary cavity. Osteophyte. B—Röntgenogram of A. Confirms the above-mentioned features.

Clinically one hopes to produce a fusion of the free extremities of tibia and fibula in order to attain a firmer stump for the fitting of an artificial limb. If this result is obtained there is much less pain and discomfort to the patient. Hence the osteophyte, which is a distinct detriment in a femoral stump, becomes of material service in amputations of the leg below the knee.

A B

FIG. 9.—Amputation right tibia, fibula. W.R.U. 1291. Male, Negro, forty-two years. A—Amputation through upper leg. Rounded stumps. Quiescent osteoporotic shafts. Medullary cavities closed. Osteophyte uniting free ends of bones. B—Röntgenogram of A. Note particularly the condensed caps closing the medullary cavities.

ASSEMBLED RESULTS OF THE STUDY

1. In the foregoing description we have traced the successive stages of healing of bone in amputation stumps and noted the final results obtained in the bones through which the amputation has been performed.

2. We have found the same successive stages in bone healing which are characteristic of repair in fractures. These are, in order, vascular erosion in bone end and adjacent shaft; consequent molecular disintegration of bone adjoining the site of amputation; rounding of bony stump itself; quiescence in osteoporotic shaft; closure of medullary cavity by a cap of bone which rapidly becomes condensed; restrained production or absence of osteophytes.

3. We have been able to trace, in general terms, the time element in such phenomena and find that it accords well with the time of appearance of the corresponding phenomena in healing fractures.

4. The original erosion of the amputated end is already well advanced within five or six days of the surgical trauma, even before the marks of the saw cut are obliterated from the bone. Flake-like sequestra undoubtedly occur and probably separate in less than three weeks. These are usually absorbed but may be exfoliated if the wound suppurates. Endosteal callus of small amount has appeared within eleven days. This is shortly followed by periosteal callus which becomes condensed into a sclerosed cancellous texture within seventeen days. Later, the texture of the periosteal callus takes on a more compact appearance. In amputation stumps the production of callus is much more restrained than in fractures. Following upon these phenomena is the formation of a cap of bone closing the medullary cavity. Frequently the cap is imperfect owing to the low activity in callus production. It is not possible to define the precise origin of the cap more than to state that it is certainly developed from endosteal and definitive callus. The latter term is used, as in the description of fractures, to indicate callus arising from the severed surface itself. Lastly, osteophytes may develop. These are usually unwelcome complications of a bony stump but may be put to service in amputations of the leg if they bring about fusion of the free ends of the tibia and fibula to produce a firmer stump.

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RELATIONS OF HISTOLOGICAL STRUCTURE AND CLINICAL GROUPING TO THE PROGNOSIS OF CARCINOMATA OF THE BREAST AND UTERINE CERVIX

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In recent years numerous reports have appeared in the medical literature dealing with investigations into the correlations existing between the histological structure and prognosis of malignant tumors. As a detailed description and critical consideration of the work done by others on this subject would surpass considerably the scope of this paper, our own studies only are presented in this communication.

The most reliable information in regard to the prognosis of a malignant tumor is at present obtained by an evaluation of the histological structure and a consideration of the clinical extent. These two factors have been taken into account in the work presented in this paper.

The Histological Malignancy.—For the determination of the histological malignancy twenty factors characterizing the degree of differentiation and anaplasia of the tumor parenchyma and the antiblastic condition of the stroma were evaluated according to the method elaborated by one of us (Hueper). The list of these factors composing the "histological malignogram" (Hueper) and showing the numerical values given is as follows:

I. *Special cellular and structural characteristics of carcinoma:*			Valued 5–20
1. Special cell type of carcinoma:	valued	1–4	
2. Nucleo-cytoplasmic coefficient:	"	1–4	
3. Number of "pencil-cells":	"	1–4	
4. Infiltrative growth of carcinoma:	"	1–4	
5. General type of carcinoma (parenchyma - stroma relation):	"	1–4	
II. *Characteristics of cytoplasm:*			" 5–20
6. Irregularity in size of cells:	"	1–4	
7. Irregularity in shape of cells:	"	1–4	
8. Distinctness in outline of cells:	"	1–4	
9. Chromatism of cytoplasm:	"	1–4	
10. Functional activity of cells:	"	1–4	
III. *Characteristics of nuclei:*			" 6–24
11. Irregularity in size of nuclei:	"	1–4	
12. Irregularity in shape of nuclei:	"	1–4	
13. Chromatism of nuclei:	"	1–4	
14. Hyperchromatism of nuclei:	"	1–4	
15. Number of mitoses and prophases:	"	1–4	
16. Irregularity of mitoses:	"	1–4	

IV. *Characteristics of stroma:*		Valued 4–16
17. Character of stroma:	Valued	1–4
18. Vascularity of stroma:	"	1–4
19. Type of cellular infiltration:	"	1–4
20. Amount of cellular infiltration:	"	1–4

The numerical values obtained by this method are added and the sum resulting is called "histological malignancy-index" (Hueper) which represents the numerical expression of the potential malignancy of a given tumor as evidenced by its histological structure. The numerical range of the "histological malignancy-index" is between 20-80. The evaluations show that the malignancy increases with an increase in the value of the malignancy-index. For a detailed description of the technic employed reference is made to previously published papers.

The Determination of the Clinical Extent of the Growth.—The clinical extent, the second factor, which has an important effect upon the prognosis of malignant tumors is represented in the clinical grouping of the carcinomata of the uterine cervix and of the breast as elaborated by one of us (Schmitz). Its estimation is based on physical findings. The carcinomas are divided into primary and secondary or recurrent. The factors which determine the clinical grading of the primary carcinomas of the uterine cervix are:

Group P1 signifies a cancer growth clearly localized within the cervix. It should be about 1 cm. in diameter. The size is determined by palpation and inspection. The genital organs are movable within normal habits.

Group P2 indicates a growth which has extended to the periphery of the cervix in a longitudinal or transverse direction. The uterus has an impeded movability due to a doughlike consistency and decreased elasticity of the paracervical tissues.

Group P3 means that either one or both parametria or the regional lymph nodes have been invaded, a fact which is elicited by rectal examination. The tumor mass is movable though elasticity of the tissues is lost.

Group P4 includes the carcinomata with absolute fixation.

The primary carcinomas of the breast are classified according to similar considerations:

Group P1 represents a clearly localized, freely movable growth which is not adherent to skin or pectoral fascia and which has not produced any metastases in the regional lymph nodes as evidenced by preoperative palpation and corroborated by post-operative histological examination.

Group P2 signifies a single node which is still freely movable but which has produced metastases either in the breast or lower axillary lymph nodes and primary multiple tumors as observed after chronic cystic mastitis.

Group P3 includes those tumors which have become adherent to the skin or fascia or both. There may be multiplicity in the breast and metastases in the lower and upper axillary lymph nodes. The primary and metastic tumors are movable, though movability is impeded.

Group P4 means that the tumor has either permeated the entire skin with

ulceration, or has become fixed to the chestwall, or has produced fixed metastases in the upper axillary lymph nodes, or has invaded the supraclavicular lymph nodes, or caused multiple invasions of the skin. The other breast may be also involved. Metastases may have been produced in distant organs. The primary and metastatic growths are firmly fixed to the skin or chestwall or axillary structures.

The characteristics of the groups in the recurrent carcinomas are: Group R1 contains the local but freely movable, clearly localized recurrence; Group R2 the regional, freely movable recurrence; Group R3 the local and regional movable recurrence; and Group R4 the local or regional recurrence with fixation or secondary invasion in distant organs (supraclavicular lymph node, bone, etc.).

The clinical grouping has a threefold purpose. It indicates those cases which invariably have a poor prognosis (Group 4). It furnishes furthermore the correct indications for treatment and is an aid in establishing exact statistics to determine the therapeutic efficacy of either operation or radiation. The following table comprises the cases of primary carcinomas of the cervix and breast admitted and treated up to the end of 1924.

Five Year Good End-Results in Primary Carcinomata

Group	CERVIX			BREAST		
	Number	Well	Per Cent.	Number	Well	Per Cent.
P 1	23	18	78.27	13	9	69.23
P 2	48	20	41.68	29	15	51.72
P 3	161	20	12.42	34	4	11.77
P 4	100	0	0	31	1	3.23
Total	332	58	17.50	107	29	27.10

Operability *i.e.* Groups 1 and 2 is 21.09 per cent. Relative curability in 71 operable cases was 38, or 53.52 per cent. with the use of radium and X-rays.

Operability *i.e.*, Groups 1 and 2 is 39.25 per cent. Relative curability in 42 operable cases was 24, or 50.72 per cent. with operation and post-operative X-ray treatment.

RESULTS OF STUDY

Malignancy indices were determined from 225 cases of carcinoma of the uterine cervix and 136 cases of carcinoma of the breast. The patients entered Mercy Hospital in the years 1922-1927.

Malignancy Index and End-Results.—The prognostic value of the histological malignancy index was tested against the end-results obtained. The malignancy indices were first determined and they then were entered in the clinical histories. Thus the work of the pathologist could not be influenced by the end-results obtained. The following classification of the end-results was made: Clinical End-result 1 means that the patient was free from symptoms and showed anatomical healing three years after termination of the treatment. End-result 2 indicates death during the third year. End-result 3 means death during the second year, and End-result 4 death during the first year after treatment. Cases of Clinical Group 4 are eliminated from the following compilation as they almost always have a poor prognosis regard-

less of the histological malignancy index and the treatment used. The end-results were known in 100 cases of cervical carcinoma and 71 cases of carcinoma of the breast.

To test the histological malignancy index against the good end-results i the values were divided into four even parts. The average malignancy index value of cervix carcinomas is 55.76 and for breast carcinomas 56.04; hence 56 was taken as the average value. Each malignancy index group has a range of 12 points, that is: Group 1 from 32 to 44, Group 2 from 45 to 56, Group 3 from 57 to 58, and Group 4 from 69 to 80.

	Breast	Cervix	Breast	Cervix	Breast	Cervix	Breast	Cervix
Malignancy index	32–44		45–56		57–68		69–80	
Number of cases	2	5	24	29	24	26	3	2
Number of End-result 1.	2	4	18	17	12	7	0	0
Percentage of End-result 1.	100	80	75	58.62	50.0	26.92	0	0

Three cases of Clinical Group 4 were excluded from the compilation of the cervical carcinomas.

The practical significance of the histological malignancy index is strikingly demonstrated by the agreement of the figures given above. The general average malignancy index of the 136 breast carcinomas is 56.04 and that of the 225 carcinomas of the uterine cervix is 55.76. The average malignancy index of 32 breast carcinomas with end-result 1. is 53.20 (range 40-64) and of 31 cervical carcinomas is 52.45 (range 40-64). Eleven of these 32 breast cancers or 35.5 per cent. have a malignancy index above the general average index of 56.04 and 8 of the 31 cervical cancers or 25.81 per cent. are above the general average of cervical carcinomas of 55.76. The average malignancy index of 22 breast carcinomas with an end-result 2-4 is 59.88, while that of 36 cases of cervical cancers with end-result 2-4 is 59.39. Sixteen of these 22 cases of breast cancer or 72.82 per cent. have a malignancy index above the general average malignancy index, while 22 cases of 61.1 per cent. of the 36 cervical carcinomas have a malignancy index above this general average malignancy index.

Average Malignancy Index

	Cervix	Breast
End-result 1	52.45	54.48
End-result 2	53.00	59.11
End-result 3	60.00	58.70
End-result 4	61.00	61.35

This table shows that the malignancy index has a tendency to be higher in cases which take a rapid course than in those with a slow course.

Distribution of the Carcinomas in the Malignancy Groups

	Cervix	Breast
Group 1 (32–44)	16.82 per cent. (38 cases)	2.94 per cent. (4 cases)
Group 2 (45–56)	42.92 per cent. (98 cases)	36.76 per cent. (50 cases)
Group 3 (57–68)	36.72 per cent. (83 cases)	56.62 per cent. (77 cases)
Group 4 (69–80)	3.54 per cent. (8 cases)	3.68 per cent. (5 cases)

It is evident from this compilation that the carcinomas of the breast have on the average a somewhat higher histological malignancy than those of the uterine cervix, as the carcinomas of the breast are less frequent than those of the cervix in the first two malignancy groups.

Special Cell Type and Malignancy Index

Cell Type	Cervix	Breast
Cell type 1	45.67 (range 38–54)	40.5 (range 40–41)
Number of cases	9	2
Cell type 2	48.62 (range 32–68)	51.75 (range 44–62)
Number of cases	61	16
Cell type 3	54.65 (range 37–70)	54.70 (range 47–70)
Number of cases	106	43
Cell type 4	60.76 (range 41–75)	56.41 (range 42–72)
Number of cases	49	91

In the compilation of the breast carcinomas 16 malignancy indices of tumors with changed cell type in recurrences were included.

This compilation permits the conclusions that the special cell type or the degree of differentiation runs to a certain extent parallel with the degree of histological malignancy in the respective types. But it is also apparent that the evaluation of a carcinoma by the method of the malignancy index gives far more reliable results than the grading of carcinomas on the basis of cell type or degree of differentiation. The differences between the average malignancy indices of the different cell types are not marked enough to indicate definite differences in malignancy and prognosis for most of the groups.

GENERAL TYPE OF CARCINOMA AND MALIGNANCY INDEX

The relation existing between the general type, the malignancy index and the prognosis of a carcinoma was studied to ascertain the fact whether highly cellular tumors are more malignant than oligo-cellular (zellarm). For this purpose the average malignancy indices of the carcinomas of the general type 4 were compared with those of the general type 1.

Average Malignancy Index

	Cervix	Breast
General type 4	54.11	57.44
Number of cases	120 (53.33% of total number)	65 (47.06% of total number)
General type 4	52.30	55.16
Number of cases	20 (8.89% of total number)	19 (13.97% of total number)

One may state that, in general, cellular or medullary growths are more likely to have a loose, vascular stroma with a more or less marked round cellular infiltration, while the rather oligo-cellular or fibrous or scirrhous cancers show usually a fibrous or hyalinized stroma with few vessels and scant round cell infiltration. Deviations from this rule occur, but were not taken into consideration.

The numerical difference between cancers of general type 4 and general type 1 is three points if all other factors are equal. As is apparent from the table the actual difference is less than anticipated (1.81 and 2.28). More-

over one has to consider that the antiblastic status of the stroma of medullary cancers is usually less marked than that of scirrhous ones. This statement is substantiated by the following figures: In medullary cancers of the breast the stroma contributed on the average 12.00 points to the malignancy index. In medullary cancers of the cervix the stroma added 11.28 points; while in scirrhous carcinomas of these organs only 9.67 points (breast) and 9.9 points (cervix) respectively were contributed to the malignancy index by the stroma. The differences are 2.33 points for the breast and 1.38 points for the cervix. If these observations are taken into account it becomes evident that the parenchyma of scirrhous cancers is more malignant on the average than that of medullary tumors. The blastic qualities of the parenchyma of a scirrhous cancer of the breast surpass by 3.05 points (0.72 plus 2.53) and those of the cervix by 2.58 points (1.81 plus 1.39) those of the medullary tumors of the respective organs.

CONCLUSIONS

1. A description of the determination of the histological malignancy index and the classification of the clinical groups based on the extent of the carcinoma has been given.

2. The histological malignancy indices were determined in 225 cases of carcinomata of the uterine cervix and 136 cases of carcinomata of the breast. The end-results were known in 100 cases of cervical and 71 cases of mammary cancers.

3. The prognostic value of the histological malignancy index was tested against the end-results obtained. The result is that the malignancy increases with an increase in the value of the malignancy-index. In Malignancy Group 1 the good end-results were 100 per cent. in breast carcinomata and 80 per cent. in cervix carcinomata. In Malignancy Group 2 the good end-results were 75 per cent. in breast cancers and 58.6 per cent. in cervix cancers. In Malignancy Group 3 the good end-results were 50.0 and 26.9 per cent. respectively; while in Malignancy Group 4 good end-results were not obtained in a single instance.

4. The clinical grouping gave relatively similar values. The five-year good end-results in Clinical Group 1 were 69.23 per cent. in breast cancers and 78.27 per cent. in cervical cancers. In Clinical Group 2 they were 51.72 and 31.68 per cent. respectively; in Clinical Group 3 they were 11.77 and 12.42 per cent. respectively; and in Clinical Group 4 they were 3.23 per cent. and 0 respectively.

5. The study of the degree of histological malignancy and the extent of the growth give valuable data in the prognosis and treatment of carcinomata of the breast and uterine cervix.

Thanks are due to Dr. W. Barnes, Dr. J. Golden, Dr. C. Connor, Dr. G. Morgan, Dr. L. D. Moorhead, Dr. M. McGuire, Dr. T. Sawyer for their kind coöperation in this work by supplying us with the histories and end-results of their cases.

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RADIATION IN THE TREATMENT OF RECTAL CANCER

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Rectal cancer is a relatively common disease. It occurs more frequently in males than in females; it attacks the young as well as the aged; many cases being encountered in young adults. Despite its relatively common occurrence, rectal cancer is seldom diagnosed early, a fact which increases the difficulty of successful treatment.

The most effectual methods of treatment for early cases are: (1) Radiation therapy. (2) The combined use of radium and surgery. At Memorial Hospital we prefer to use radiation therapy as the principal factor of treatment of rectal cancer. We supplement this treatment with surgery in those cases in which surgical interference offers an additional advantage. Dosage and technic of radiation therapy, and the type of operation performed are governed by the aspects of the given case.

The following variable factors should be carefully considered before treatment is outlined: (1) Ability of the patient to withstand appropriate treatment; (2) location and accessibility of the cancer; (3) size of the primary tumor, together with the degree of infiltration and dissemination; (4) grade of malignancy of the tumor; (5) degree of radiosensitivity of the cancer tissue.

The wide variations of these factors indicate that more gratifying results will be obtained when treatment of carcinoma of the rectum is governed by the above clinical and pathological aspects, rather than when a routine method of procedure is adopted. Experience has proven that because of these wide variations, appropriate treatment for a given case may vary from the most radical form of rectal surgery to an application of external radiation of sufficient intensity to bring about the desired result.

The first successful surgical operation occurred in 1826, when Lisfranc extirpated a cancerous rectum. Until Janeway's work, methods other than surgical were of little importance. His preliminary report in 1920 demonstrated that applications of radium were valuable in the treatment of rectal cancer. Since that time there has been a gradual improvement in radiation therapy. The advancement both in surgical and irradiation technic renders the following four procedures most effectual for eradication of this disease: (1) Application of physical agents, namely—radium and high voltage Röntgen rays; (2) combined application of physical agents and surgery; (3) surgical removal by the abdomino-perineal route (completed in one or two stages); (4) perineal resection, preceded by a colostomy. Any of the above methods is capable of producing satisfactory results in properly selected cases.

A brief analysis of the variable factors presented in a miscellaneous group of cases indicates rather clearly why selective treatment is superior to any routine method.

A.—*The general condition* of the patient should be given preliminary consideration. Old age, poor general health, and obesity, occasionally contraindicate employment of the most effective surgical procedure, or forbid intensive applications of radiation therapy. The majority of patients withstand the latter better than radical surgery. Abdomino-perineal resections are accompanied by a higher mortality than those through the perineum. Therefore, even though the disease may not be far advanced, palliative measures may be preferable in certain aged, debilitated, or very obese patients.

B.—*Location and accessibility of the tumor* have considerable bearing upon the method of choice. From the surgical standpoint, location often determines the method of procedure. Tumors of the recto-sigmoidal juncture are usually removed by the abdomino-perineal operation, and tumors of the mid and lower rectum by the less radical procedure of a perineal resection preceded by a colostomy. However, when surgery is indicated, the grade of malignancy, together with the location of the tumor, must be taken into consideration. If the pelvis is large, small tumors at the recto-sigmoidal juncture, which are of low-grade malignancy, may be successfully removed by the perineal route; whereas highly malignant tumors in a lower location are seldom completely removed by surgery alone, except by the more complete abdomino-perineal dissection. The accessibility of the tumor may also largely determine the value of radiation therapy. Unless the tumor is sufficiently radiosensitive to disappear after external radiation, interstitial radiation is required. Adequate interstitial irradiation is obtained by uniform distribution of the proper dose by means of radium seeds. When the tumor is accessible, this effect is not difficult to obtain. However, there are inaccessible tumors that do not lend themselves to adequate interstitial irradiation.

C.—*Size and fixation of the primary mass* are important factors with respect to treatment and prognosis. Surgical interference to be successful requires the removal of all malignant cells. The size of the tumor mass within the rectal wall is of less importance than is the degree of extension of the disease into the surrounding tissues. The extent of infiltration in tumors of highly malignant character may be difficult to determine by palpation. When radium implants are required the size of the mass is important, since adequate dosage is determined by the size and the radiosensitivity of the tumor.

D.—*The wide variation in the degree of malignancy* of cancer in this vicinity is manifested clinically in the consideration of a miscellaneous group of untreated cases. The average duration of the disease from the onset of objective symptoms in this group is about two years; patients with the most active form of rectal cancer seldom live more than twelve months, although patients with less malignant tumors may live three or more years.

There are two methods of determining the grade of malignancy of rectal cancer. First, by histopathological study of a small section of the tumor. Secondly, by clinical data secured from a detailed history and from a general and local examination of the case.

1. Histopathological grading may furnish an estimate, in a certain percentage of cases, of the degree of malignancy. Sections must, however, be provided which contain the true characteristics of the primary tumor. As secondary infection tends to alter these characteristics, it is not always possible to estimate the grade of malignancy from a biopsy of an ulcerating rectal cancer. When pathologists, however, are given the gross specimen and can select the area for study, then the pathological classification is quite satisfactory. While a biopsy report indicating the grade of malignancy is valuable, nevertheless, too great importance should not be attached to it unless such report is in keeping with the clinical data of the case.

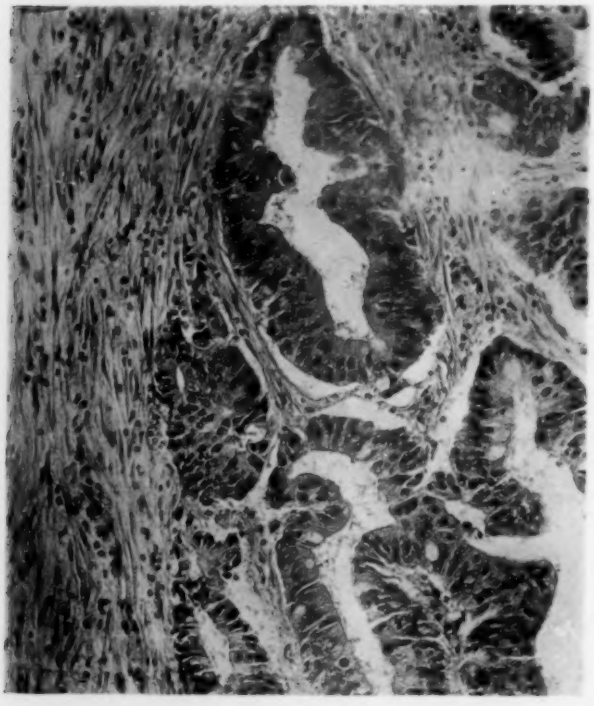

FIG. 1.—Slowly growing, late infiltrating and very late disseminating.

2. The clinical data presented in the average case when referred for treatment is usually sufficient to determine to an approximate degree the grade of malignancy. Such data include the age at which the cancer occurred; the effect of the disease upon the patient; the location, size, shape, induration and ulceration, together with the appearance of the tumor when viewed through a proctoscope. The consideration of these factors suggests a clinical grading of malignancy of rectal cancer corresponding to the rapidity of growth, rate of infiltration, and trend toward dissemination of the tumor. The following more or less definite five groups are suggested: (*a*) Slowly growing, late infiltrating and very late disseminating (this type has a marked tendency to early stenosis); (*b*) uniformly growing, infiltrating and disseminating; (*c*) rapidly growing, early infiltrating and late disseminating; (*d*) slowly growing, early infiltrating and moderately early disseminating; (*e*) slowly growing and late infiltrating, early disseminating types.

(*a*) The stenosing, slowly growing, slowly infiltrating and very late disseminating type (Fig. 1) is most commonly found in old age. The early symptoms are obstructive in character. Ulceration is superficial and does not occur early. The discharges of mucus are seldom frequent and are stained with blood only at irregular intervals. These tumors are very firm and there is but a slight outgrowth into the lumen; they have, however, a tendency to encircle the bowel, a condition which produces a constriction rather than an obstruction. Due to the lack of vascularity, and a large amount of fibrosis, trauma produces but slight bleeding. The recto-sigmoidal juncture is the most common location for these low-grade malignant tumors which cause but slight impairment of the general health until obstructive symptoms are marked.

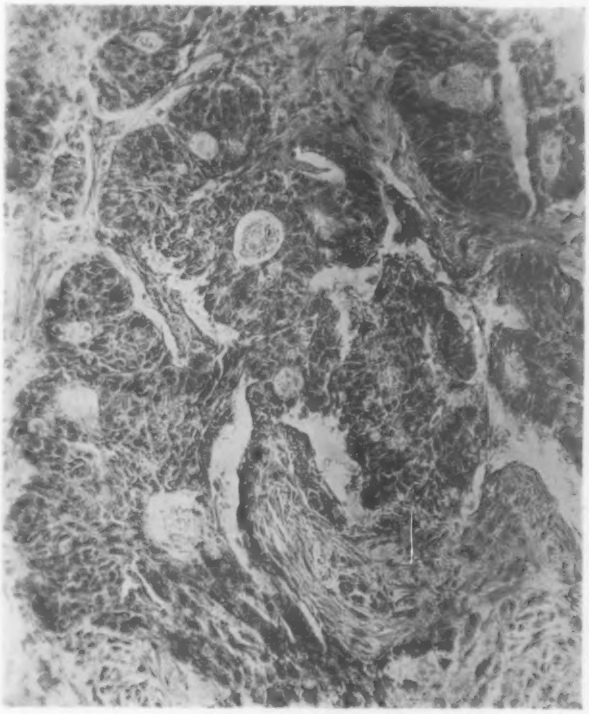

FIG. 2.—Uniformly growing, infiltrating and disseminating.

(*b*) The second group in which there is more or less uniformity in the rate of growth, rate of infiltration and dissemination (Fig. 2) includes more than 50 per cent. of rectal cancers. This type is occasionally found in young subjects but usually occurs in patients between forty-five and sixty-five years of age. The history is that of a gradual onset, the subjective symptoms being followed by objective symptoms of increasing severity. The duration of the disease in untreated patients varies between eighteen months and three years. The tumor enlarges at rather a slow rate and attains considerable size before there is infiltration beyond the muscle coat. The disease extends by continuity of tissue rather than through the lymphatic and blood streams until the primary mass is definitely fixed. One can usually predict the amount of dissemination by the duration and severity of symptoms; by the effect upon the patient; and by the size, degree of fixation, and infiltration of the tumor, since dissemination is proportionate to the degree of these other factors. Palpation and proctoscopy of this type of tumor present rather a typical picture. Although these cancers are small and freely movable with the rectal wall in the early stages, they are seldom

recognized at this time. Increasing in size, they tend to protrude into the lumen of the bowel and produce a variable degree of obstruction. Induration is about midway between that of the very cellular and the scirrhous varieties. Ulceration is superficial in the beginning but gradually becomes deeper and involves a large area. Areas of degenerated tissue may be found but the bulk of the mass is moderately vascular as shown by the amount of bleeding when trauma is induced by the proctoscope.

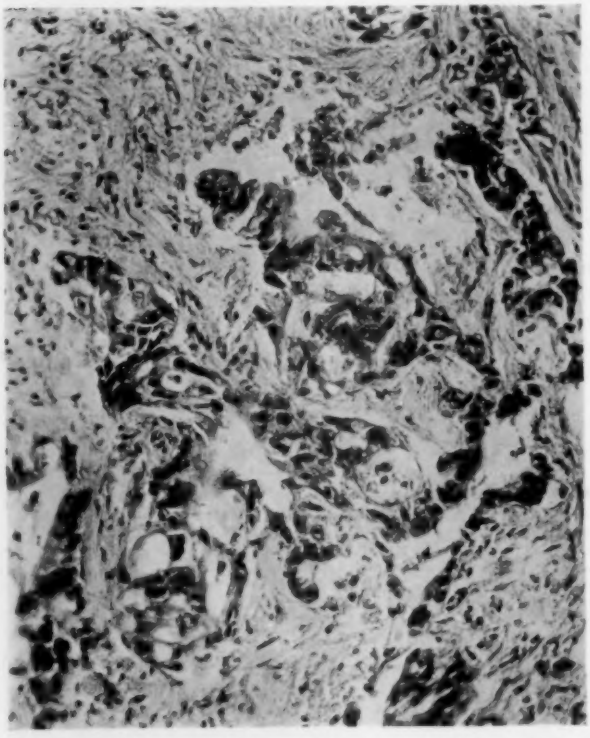

FIG. 3.—Rapidly growing, early infiltrating and late disseminating.

(*c*) The majority of the rapidly growing, early infiltrating, and late disseminating cancers (Fig. 3) occur in women between the ages of twenty and thirty, although this very malignant type of cancer may be found in patients of more mature years. In this grade of malignancy the disease is seldom recognized until the greater part of the circumference of the bowel is involved. Many of our patients had been subjected to an abdominal or pelvic operation before the true nature of the disease was determined. The tumor enlarges rapidly and infiltrates the adjacent structures early in the course of the disease, while at the same time the mucous membrane is pushed inward. In many instances annular stricture occurs before ulceration has taken place. When the mass has attained considerable size, ulceration rapidly involves a large area. Induration is less marked than in the types previously mentioned. Before the onset of ulceration the symptoms are mild and the general condition of the patient is not seriously affected, but after ulceration there is a marked change, manifested by anæmia, loss of weight and strength, and by increased irritability of the rectum. Many of these tumors are the seat of deep secondary infection which produces an elevated evening temperature. Although this type of tumor tends to infiltrate the adjacent tissues early, it does not disseminate to distant locations until the terminal stage. The appearance varies with the degree of ulceration and degeneration.

(*d*) The slowly growing, early infiltrating, and moderately early dis-

seminating type (Fig. 4) is frequently discovered in young or middle-aged males. Its favorite location is the anterior quadrant of the lower rectum. The rate of enlargement is slow but ulceration of the mass and infiltration beyond the muscle coat occur early, being often accompanied by dissemination into the nearby lymphatic nodes, although the liver may not be involved until the advanced stages of the disease. These slowly growing tumors present a picture entirely different from that of the rapidly growing types. When first recognized they are usually small, although the objective symptoms have been in evidence for several months; they are usually sessile and protrude slightly into the lumen of the bowel; there often exists a deep ulcerating crater on the surface. Early infiltration causing partial fixation occurs at a site adjacent to the crater. These moderately indurated tumors bleed easily when traumatized. Constriction of the rectum never takes place early. The real criterion by which the extent of the disease may be recognized lies in an accurate determination of the extent of the infiltration, as the general health is not noticeably affected until definite fixation has taken place.

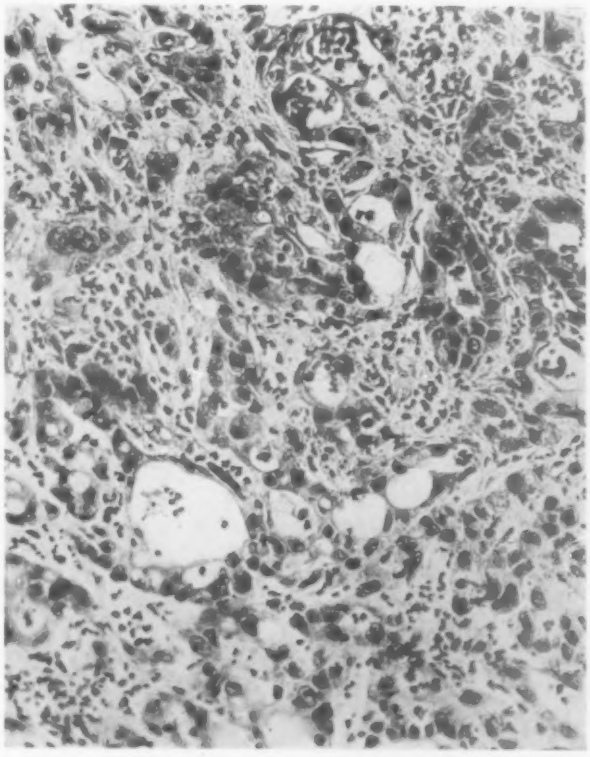

FIG. 4.—Slowly growing, early infiltrating and moderately late disseminating.

(*e*) The latter two clinical types (*i.e.*, the third and fourth) tend to infiltrate early into the adjacent structures and the nearby lymphatic nodes, while the characteristic feature of the fifth, the slowly growing, early disseminating type, is early migration of the cancer cells to distant locations. The rapidity with which this occurs suggests spread by way of the blood stream, rather than by the lymphatic route. Although this type is comparatively rare, nevertheless two clinical varieties are recognizable—one, a stony hard tumor with very superficial ulceration, is usually circular and may be freely movable with the rectal wall at the time of the primary examination; the other, early disseminating variety is somewhat similar to the slowly growing, early infiltrating type except that it has greater consistency and is usually deeply infected. Early disseminating tumors occur

at all ages, but are most common between the ages of forty and sixty-five years. The local symptoms are usually comparatively mild but also vary in accordance with the degree of ulceration.

The separation of rectal cancer into the above five clinical types offers a working classification in this disease. Although a number of typical malignant tumors, such as adenomas and papillomas undergoing malignant changes, colloid cancers, etc., will be observed, there is but little difficulty encountered in placing them within their appropriate group. The importance of determining the degree of malignancy of a given rectal cancer is self-evident if the most appropriate treatment is to be adopted. Cancers which have slowly infiltrating and disseminating characteristics remain a local disease for many months and may be eradicated by methods of moderate intensity, whereas highly malignant cancers such as those comprising the latter three groups demand more radical treatment.

E.—*Radiosensitivity of rectal cancer:* Experience has proven that there is a marked variation in the degree of radiosensitivity of the rectal cancer. This important factor influences the selection of treatment and governs the intensity of radiation therapy. Tumors of low-grade radiosensitivity may often be influenced to the same degree as those of the most radiosensitive nature by employing more intensive irradiation at the site of the mass.

The classification, operable or inoperable, from the point of view of treatment is largely based upon the condition of the patient: the location of the tumor and degree of fixation of the primary mass, together with the possible existence of metastatic lesions. More recent observations in rectal carcinoma reveal the importance of the latter two factors, namely, the degree of malignancy and the degree of radiosensitivity of the cancer cells, which should be considered in forming a workable classification. If these additional factors are to be considered a part of the basis of classification, the division into favorable and unfavorable groups appears more appropriate than the former surgical classification of operable and inoperable. Unless recognized very early in the course of the disease, tumors of the more malignant grade tend often to recur after surgical removal; consequently, despite the fact that they appear operable, they are usually unfavorable for surgery because of this tendency. Unless the grade of malignancy is determined, digital examination will often convey the erroneous impression that all the cancer cells can be removed. On the other hand, tumors that are definitely fixed and in which surgical removal is impossible, may have a favorable outcome, provided the disease is amenable to radiation therapy. The prognosis therefore, depends on the radiological, as well as the surgical aspects of the case. Patients constituting the favorable group are those in whom there is a prospect of at least a three-year "clinical cure."

Previous to the institution of radiation therapy, radical surgery was the only method of treatment by which it was possible to hope for eradication of rectal cancer. A comparative review of the literature indicates that about 60 per cent. of the cases are considered operable; that of those operated upon the immediate mortality is about 16 per cent.; and that only 25 per

cent. to 30 per cent. of the patients surviving the operation are alive at the end of three years. Assuming that these figures represent the true status of surgical treatment, we have only 12 per cent. to 15 per cent. of patients with cancer of the rectum alive at the end of three years, after 60 per cent. have been submitted to a radical operative procedure. The small percentage of satisfactory results following radical surgery in the so-termed operable group, and the lack of palliation provided by surgery in the inoperable group, encouraged the investigation of other methods of treatment. The reports of Janeway,[1] Quick,[2] Kelly and Ward,[3] and others, demonstrated the importance of radium applications in the treatment of this disease. The gradual improvement of the technic in the use of the physical agents[4] over a period of ten years has greatly increased the appreciation of this method of therapy. In addition, observation of patients treated with radium and high voltage Röntgen rays have led to a more discriminating selection of cases and to a more satisfactory treatment of rectal cancer in general. Although radiation therapy has its limitations, nevertheless it is capable of producing satisfactory results in selected cases, and often affords an additional advantage when combined with the most suitable forms of surgery. Moreover, it provides valuable palliation in many patients of the unfavorable group.

The course of treatment for each case classified as favorable is outlined at the beginning and each step is carried out in systematic manner. Satisfactory results seldom follow haphazard technic. The various steps contemplated may consist of external radiation, interstitial radiation, colostomy, and radical excision. In accordance with the intensity of treatment required, favorable patients are divided into the three following classes: (*a*) Those in whom external radiation alone is sufficient; (*b*) those who require both external radiation and interstitial radiation (a colostomy may or may not be an advantage); (*c*) patients in whom a combination of radiation therapy and radical surgery offers the greatest possibilities. The surgical procedure in the latter class is determined by the extent of the disease, location of the tumor, degree of malignancy, and condition of the patient.

External Radiation.—The chief factor upon which the efficiency of external radiation depends is the radiosensitivity of the cancer cells. All rectal cancers are deep seated. The distance from the skin surface to the tumor varies according to location of the tumor and size of the pelvis. Cancers situated near the surface obviously receive a higher percentage of the skin dose than those situated at a greater distance. External radiation not only affects the primary focus but includes within its field of activity the surrounding lymphatics. The employment of sufficient portals of entry about the pelvis allows for a more or less uniform influence to be exerted upon the primary mass and the surrounding area. Consequently external radiation, when adequate, is not only the ideal method of radiation therapy but the ideal method of treatment for rectal cancer.

The most efficient form of external radiation is by means of the radium

pack. When sufficient radium is not available for this form of applicator, high voltage Röntgen rays may be substituted. The best results, however, appear to follow the combined applications of radium and high voltage Röntgen rays with radium predominating.

Dosage.—Three to seven portals of entry about the pelvis are usually employed, with a maximum dose for each of about 50,000 to 60,000 millicurie hours of radium, when used at fifteen centimetres from the skin, plus an application of high voltage Röntgen rays. The time required for external applications, depending upon the size of the dose, is usually two to six weeks. Slight variation in dosage of these two agents is required with different patients; the skin tolerance determines the maximum amount of external radiation at each portal. The skin must not be permanently damaged but slight blistering is of no consequence. Unfortunately, owing to the low degree of radiosensitivity of malignant tissue, and to the depth of the tumor mass from the skin surface, and also the susceptibility of the skin to irradiation, sufficient dosage of external radiation cannot always be given to cause a complete disappearance of the disease. Under these circumstances, additional treatment is required.

The following report of a case treated by external radiation alone, reveals the importance of this method of application:

A male, fifty-seven years of age, in fairly good physical condition, was referred to the Memorial Hospital, November 14, 1927. *History:* Symptoms began in July, 1927, with an attack of diarrhœa. The stools at that time contained considerable blood and mucus; during the four months prior to admission he passed mucus unstained with blood six or seven times daily. There was marked flatulence and difficulty in obtaining satisfactory evacuation of the bowels. He tired easily and had lost ten pounds in weight. Local examination revealed an indurated mass involving the anterior two-thirds of the circumference of the rectum; the lower limits of the mass extended to within eight centimetres of the anal skin margin. The size of the tumor was estimated to be about 2½ by 3½ centimetres. There was superficial ulceration over the area of the tumor which protruded slightly into the lumen of the bowel. The exact extent of infiltration and the degree of fixation could not be determined because of unsatisfactory palpation. A moderate amount of bleeding was produced by the proctoscope and by taking a section for biopsy. *Pathological report:* Adenoma malignum, grade II; cells small, probably radiosensitive. Treatment consisted of applications of high voltage Röntgen rays and external applications of radium with the four-grain element pack. The pack was employed at 15 centimetres from the skin. *Dosage:* Between November 28 and December 12 this patient received an application of high voltage Röntgen rays over four areas; the anterior and posterior right and left pelvis. Treatments consisted of sixty-minute exposures with four milliamperes of current. This pelvic cycle was repeated between January 3 and January 13, 1928. An application of high voltage Röntgen rays was given over the perineum January 20 and repeated March 9, 1928. Radium applications given from February 16 to March 2 amounted to 55,000 millicurie hours of radium at 15 centimetres from the skin over the centre of the pubes and lower abdomen, and 55,000 millicurie hours, posteriorly over the sacrum. *Progress of the case:* January 3—patient felt somewhat improved. January 14, further improvement in the general condition, a decrease in the amount of mucus discharge, and a slight reduction in the size of the tumor. The ulcerating area which was noted at the first examination was completely covered with epithelium. January 31, patient was free of symptoms, with marked

improvement in the general condition and further reduction in size of the tumor. March 30, the tumor in the rectum had completely disappeared. This patient has gained twenty-five pounds in weight and remains free of recognizable cancer.

INTERSTITIAL RADIATION.—A number of methods of applying radium have been attempted in the effort to supply adequate irradiation at the site of those tumors in which external radiation was insufficient for eradication. These methods consisted of placing radium or the emanations of radium adjacent to, or into the tumor mass. Surface applicators, or tubes arranged in tandem, placed within the rectum adjacent to the tumor, received great popularity for a time. This form of application was only of low-grade palliative value and was accompanied by a severe proctitis and tenesmus. The implantation of element and large emanation needles into the mass was also accompanied by severe reactions and indefinite results. The most effective of the earlier methods was implantation of small glass emanation seeds into the tumor. The reaction following this method was, however, very severe. Because of the ineffectiveness and the severity of the reactions, the above methods are no longer employed at Memorial Hospital. Since 1925, the method of choice has been the implantation of gold-filtered radium emanation seeds. Utilization of the gold filter for emanation seeds introduced a new phase in the radium therapy of rectal cancer.

Interstitial radiation by gold seeds may be employed alone as a method of treatment, although we prefer to use it after preliminary external radiation since this latter includes a large area of lymphatics within the field of treatment. After external applications the ulcerating area is decreased in size, the tumor is smaller, and the external limits are more easily defined. These alterations facilitate a more accurate calculation of the dose and provide a more suitable field for the implants. An interval of one to two weeks is allowed to elapse between external and interstitial applications.

Gold seeds are five to six millimetres in length, 75/100 millimetres in diameter, with a filter of 3/10 millimetres of gold. They vary in strength from one to three millicuries. Seeds of 1 to 2½ millicuries are the most serviceable for routine application. The seeds are distributed throughout the mass and left *in situ*. The dose required depends upon the size and radiosensitivity of the tumor, and should be of sufficient strength, in favorable cases, to eradicate the lesion in one application. Secondary applications are less effective and are usually followed by infection and necrosis. The amount of emanation required may vary between 10 millicuries (1300 millicurie hours) and 65 millicuries (8500 millicurie hours).

As success or failure depends upon the proper placing of the adequate dose of emanation seeds, careful consideration must be given to minute details. The seeds are implanted by the aid of long trochar needles. Their exact location in the malignant mass is determined by direct vision or by the sense of touch. When the tumor is low in the rectum, the index finger is placed within it to guide proper placement. The trochar needles are then inserted

into the tumor by passing them either through the lumen of the anal canal, or the normal perineal tissues or, in the female, through the posterior vaginal wall. Tumors situated at a higher location require the employment of an electrically lighted proctoscope. The patient is placed in the position which affords the best view of the tumor; the instrument is passed into the rectum and the actual placing of the seeds is determined by direct vision. A clear field for implantation is maintained by suction. If marked stenosis prevents a satisfactory view of the tumor, a preliminary colostomy may prove an advantage. In the construction of an artificial anus to facilitate the insertion of seeds, the section of sigmoid between the colostomy and the tumor is left comparatively short in order that a proctoscope may be passed downward through the artificial opening to the upper limits of the mass. By inserting seeds into the upper area of the tumor by way of the colostomy and into the lower section by way of the anal canal, the most adequate interstitial radiation is provided in the stenosing cases.

The following case illustrates the use of external radiation and the implantation of gold seeds:

A male, fifty-eight years of age, was referred for treatment November 26, 1926. *History:* Increasing constipation for sixteen months, frequent discharges of mucus, and pain at evacuations. There was only a slight loss of weight. Local examination revealed an indurated mass about three centimetres in diameter in the posterior quadrant of the lower rectum. *Pathological report:* Adenoma malignum. *Treatment:* Between November 30 and December 6, 1926, the patient received four high voltage Röntgen-ray treatments. December 1, external application of radium, totaling 18,000 millicurie hours, at ten centimetres from the skin, was administered posteriorly over the sacrum. December 4, he received 39 millicuries of gold seeds (5000 millicurie hours) into the tumor. There was a moderate reaction following the dose of gold seeds. This patient has remained free of recognizable cancer since April, 1927.

Use of Radium and Radical Surgery.—External radiation and the implantation of gold seeds appear to offer additional assurance against recurrence to that afforded by surgery alone. The principal factors which determine the success of surgical interference are the ability of the patient to survive the operation and the possibility of removing all the cancer cells. The common locations of malignant cells which are not removed by surgery are the nearby lymphatics and the tissues adjacent to the indurated primary focus. The object of pre-operative radiation is to affect the malignant cells sufficiently to cause partial devitalization, prior to their resection, since radiation therapy influences a larger area of lymphatics and adjacent tissues than can be included within the field of dissection. Pre-operative therapy is preferable to post-operative therapy for the reason that the tumor will serve as a suitable holder for the radium. After surgical removal, it is impossible to recognize remaining small groups of malignant cells. Nevertheless, post-operative irradiation is at times exceedingly valuable, especially when the tumor does not lend itself to adequate pre-operative therapy, and in those cases in which only a small localized area of cancerous tissue remains.

Intensive treatment by radiation therapy and radical surgery consists of four steps which are usually carried out in the following order: (1) External radiation; (2) preliminary colostomy, if indicated; (3) interstitial irradiation with the use of gold seeds in which large doses of emanation may be employed; (4) resection of the rectum. This latter procedure should be done ten to fourteen days after the implantation of gold seeds. The painful reaction ordinarily following in the diseased tissue after the use of large amounts of radium is prevented by early resection of the rectum. Special care is exercised in placing the seeds so that sterilization will be obtained in the infiltrating areas. The difficulties of surgical removal are not increased by implantation of the seeds unless an interval longer than the above is allowed to elapse between these procedures.

The type of radical operation is governed by the clinical and pathological factors of the case. The diversity of opinion as to the more suitable surgical method of approach will be greatly reduced when the degree of malignancy of rectal cancer is given equal consideration with the extent of tissue involved, and the condition of the patient.

The following case report illustrates the combined method of treatment:

A male, sixty-one years of age, was referred for treatment June, 1926. *History:* Rectal trouble characterized by attacks of diarrhœa, frequent discharges of mucus and blood, and a feeling of weight in the pelvis, had been present five months. There was a loss of twenty pounds in weight since the onset of the symptoms. Local examination revealed a stenosing cancer in the lower rectum which had infiltrated the adjacent structures deeply on the left side. *Pathological report:* Adenoma malignum. *Treatment:* Between June 30 and July 27, this patient received four high voltage Röntgen-ray applications. July 27, 37 millicuries of gold seeds (4800 millicurie hours) were implanted into the mass. A colostomy was performed July 31 and the rectum resected by the perineal route August 11, 1926. This patient made an uneventful recovery following his operation and has remained free of recognizable cancer.

Colostomy.—In the treatment of rectal cancer, the question arises in every case as to the advisability of performing a colostomy. As an artificial anus is always an inconvenience, it should be dispensed with in all favorable cases, except those in which it affords an additional advantage to treatment. If the disease can be eradicated by external radiation, there is no advantage in this procedure unless the bowel is completely obstructed. A colostomy is an advantage in about 50 per cent. of cases which require the implantations of gold seeds. In cases requiring radical resections, an artificial anus is often a life-saving procedure. Moreover, exploration of the abdomen at the time of operation may aid materially in determining the prognosis of the case.

Patients primarily considered unfavorable or inoperable are too often subjected to this unpleasant procedure, which the debilitated find especially trying, because of the former teaching that all inoperable cases of cancer of the rectum should have a colostomy. This belief originated prior to the employment of efficient radiation therapy. Nevertheless, a certain percentage of the unfavorable cases are benefited by this procedure, especially those with considerable stenosis of the bowel with indications for heavy or moderately

intensive palliative treatment. In the more advanced stages of the disease, unless there is practically a complete obstruction, an artificial anus is contraindicated. The advancement of the technic of radiation therapy during the past few years has greatly lessened the necessity for this surgical procedure.

Treatment of the Unfavorable Cases.—The frequency with which rectal cancer is allowed to progress to an unfavorable stage before recognition increases the importance of palliative measures. Palliative treatment, through restraint of growth, tends to lessen the symptoms, to improve the general condition, and to prolong life. These results are best obtained by radiation therapy, although a colostomy is, at times, an advantage. Space will not permit a discussion of the details of the management of these unfortunate patients. There is no routine dose or routine method of radiation therapy for this type of case. Each patient must be considered as an individual problem and treatment administered accordingly. Patients of this group, however, may be divided into three classes in accordance with the intensity of the radiation therapy they require: (*a*) Cases suitable for intensive palliative treatment; (*b*) those suitable for treatment of moderate intensity; (*c*) cases suitable for minimal treatment. The first class usually receives external radiation and implantation of gold seeds. The intensity of such treatment is sufficient to control the disease completely for a time. Applications are repeated in accordance with the progress of the case, which by this means may obtain marked palliation for a long period. The second class, patients suitable for treatment of moderate intensity, may receive external radiation, or interstitial radiation, or a combination of both forms. The disease may be only partially controlled by these small doses; intensity of treatments and the interval between applications are determined by the patient's condition and response to therapy.

If cases are poorly selected, or over-dosage employed, the result may be harmful. Many mistakes have been made by attempting to obtain impossible results by employing too intensive radiation therapy.

The following case report illustrates palliative treatment in an unfavorable case:

A male, fifty-six years of age, was referred for treatment July 28, 1924. *History:* Constipation existed for many months, with pain in the pelvis and frequent discharges of mucus and blood for six months; and a loss of fifteen pounds in weight. Rectal examination revealed a large definitely fixed tumor in the mid-rectum. The mass involved the greater part of the circumference of the bowel and produced an almost complete stenosis of the lumen. *Pathological report:* Adenoma malignum. *Treatment:* A colostomy was performed July 30, 1924, after the condition had been termed inoperable. Applications of high voltage Röntgen rays were given August 15 and August 18, 1924. On August 12, 15 millicuries of unfiltered emanation seeds were implanted into the mass and on November 18, another application of 7½ millicuries was administered. During 1925, this patient received the following treatment: Fourteen high voltage Röntgen-ray applications administered about the pelvis, and 27 millicuries of gold-filtered seeds implanted into the mass. In 1926, 12 high voltage Röntgen-ray treatments were given and an implantation of 12 millicuries of gold seeds were implanted into the lower limits of the tumor. He has not received any treatment since September, 1927. At

present his general condition is good. He is free from pain and leads a comfortable life. A large mass still remains in the rectum and he has occasional discharge of mucus. The early treatment of this case differed from that of today in that the glass seeds have been replaced by gold-filtered seeds, and sufficient radium is now available for external applications.

Reactions following Applications of Radiation Therapy.—The dangers and sequelæ of radical surgery are well known, but comparatively few of the profession are familiar with the reactions of radiation therapy that follow the present-day technic. In the experimental stage, the reactions were often unnecessarily severe, because of crude methods of application, improper selection of cases, and the too great doses of radium employed. The severity of reaction has been greatly reduced by the improved technic in the application of radium and by a better selection of cases. External applications do not produce severe reactions. Seldom is the patient affected sufficiently to interfere with his daily routine, but occasionally he will complain of slight loss of appetite, malaise or nausea, but vomiting is rare. These mild reactions, if they should occur, may be lessened or stopped by decreasing the time of exposure and lengthening the period between applications.

Reactions following the implantation of gold seeds depend largely upon the location of the tumor, the degree of infiltration into the areas liberally supplied by nerve filaments, the size of the dose of radium and the degree of secondary infection of the mass. In the majority of instances, if adequate radiation is employed, the reaction will not be severe. However, there are cases in which the desired result cannot be obtained without a moderately severe reaction. Provided that appropriate radiation therapy is employed, the effect upon the patient is much less severe than that produced by radical surgery. It is only reasonable to expect a certain amount of discomfort from any form of treatment that is capable of producing a satisfactory result in rectal cancers. However, the dangers of adequate radium therapy cannot be compared with the dangers of radical surgery.

RESULTS

The results of treatment in rectal cancer at Memorial Hospital have shown a gradual improvement. This has been brought about largely by a more appropriate selection of cases and by a gradual improvement in the technic of radiation therapy. The latter factor has been greatly enhanced by changing the character of the filter.

The majority of patients that have been referred for treatment have been inoperable cases. Prior to June, 1925, at which time gold seeds were first used in the treatment of this disease, various methods of interstitial irradiation were employed and but little attention was devoted to the proper selection of cases. However, of the patients treated previously to this date, eighteen are alive and free of recognizable cancer over periods varying from three and one-half to eight years.

A cross-section of the more recent work is shown by an analysis of the patients treated between June, 1925, and June, 1928. Of the cases treated during this period, there were 153 complete follow-up records. Of these, 32 were considered favorable and 121 unfavorable, with the unfavorable group divided as follows: 30 suitable for intensive palliation, 64 suitable for moderate palliation, and 27 suitable for minimal treatment.

In the treatment of the favorable group radiation therapy was supplemented with radical surgery in nineteen instances. Twenty-three (72 per cent.) of the favorable group are alive and clinically free of recognizable cancer; 4 are alive and in good general condition; while 5 are dead. One patient died of intercurrent disease, 3 died following operation, while 1 died of acute yellow atrophy of the liver several months after treatment. The post-mortem examination of this case failed to show any evidence of cancer.

Radiation therapy in the unfavorable group produced a lessening or disappearance of the symptoms and in many instances a marked prolongation of life. Of the 30 patients who received intensive palliative therapy, 11 are dead, 12 are in fairly good general condition, 4 are practically symptom-free, while 3 are free of recognizable cancer. Post-mortem examination in one case of this group (in which death occurred after several symptom-free months) failed to show either gross or microscopic evidence of cancer. The effect of radiation therapy on fourteen cases receiving only moderate intensive treatment, was chiefly manifested by a decrease in severity of symptoms and by a marked temporary improvement in general health. Ten of these patients are still alive and in fairly good condition.

CONCLUSIONS

1. Efficacy of radiation therapy in the treatment of rectal cancer has been greatly increased by improvement in technic.

2. Reclassification of rectal cancer from the standpoint of the degree of radiosensitivity and of malignancy has resulted in an improved treatment of this disease.

3. Utilization of radical surgery as an adjunct to treatment by radiation therapy is often the method of choice.

4. The effects of treatment of this disease by any single method or combination of methods are greatly enhanced when an early diagnosis has been established.

5. Recognition of the degree of malignancy is suggested as the determining factor in the choice of surgical route, whether abdomino-perineal or perineal, if surgery is indicated.

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SIGMOIDOVESICAL FISTULÆ

WITH SPECIAL REFERENCE TO SIGMOID DIVERTICULITIS

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Obviously present, because of passage of gas and particles of feces from the bladder, the cause of sigmoidovesical fistula in any given case will be difficult to determine. Probably the most frequent origin is from an abscess developing from a diverticulum of the sigmoid which ruptures into the bladder. Carcinoma of the upper rectum is probably next in frequency as a causal factor. Because of the rather protean manifestations of diverticulitis of the colon, and the relative lack of emphasis placed on this subject in surgical literature, a brief résumé of our knowledge of diverticulosis of the colon will be attempted.

It must be emphasized that diverticula of the colon occur frequently without symptoms, and as far as is known without being inflamed. In 1924 one-third of all the X-ray examinations of the colon at The Mayo Clinic revealed diverticula.[1] Spriggs,[2] of London, who has been particularly interested in this subject, found diverticula in 8 per cent. of the radiological examinations of the colon he had made. He reports 158 patients with diverticulosis, as follows:

One hundred and sixteen pelvic colon, 76 descending colon, 30 ascending colon, 31 transverse colon, 23 with whole colon involved, 7 in cæcum, 4 in rectum.

The average age of patients with diverticula of the colon is from fifty-five to fifty-eight years. Ashhurst[3] reported one patient seven years of age with this condition. One of the outstanding contributing factors seems to be adiposity, most of the patients being overweight. Constipation, which may be the result rather than the cause, is emphasized by most writers on this subject, stress being laid on the importance of increased pressure from within the bowel, from gas or hardened feces. Spriggs states as his belief that the condition is a disease and is the result of an infectious process. As diverticula formation is not uncommon, on occasion, in the whole gastro-intestinal tract, as well as in the urinary bladder, congenital anatomic variations must, it seems to me, be considered.

From a pathological standpoint, diverticula of the colon are generally multiple, and consist of hernial protrusions of the mucosa of the bowel through the muscularis into the fat of the mesentery, or into the appendices epiploica. The relation of the blood vessels running into the bowel has been emphasized as a source of weakness in the bowel wall. The fat tags along the lateral mesenteric border are most affected (Judd). The most frequent changes developing in these diverticula are the result of infection, with subsequent inflammation. Fecaliths may develop in the pouches of the diverticula,

and become marble shaped and sized. In several instances I have seen a whole colon studded with fecaliths, numbering forty to fifty, and showing no signs of gross inflammation. When infection develops in a diverticulum of the colon a chronic inflammatory process usually develops, with induration of the fat about the diverticulum, adhesions between it and surrounding structures, and in some instances the development of an abscess. The inflammatory phenomena usually come intermittently, but when an abscess develops it usually ruptures into the structure to which it is attached. This may be another loop of bowel, the rectum (Case I), the abdominal wall (Cases VII and VIII), or into bladder (Cases III, VI, VII and VIII). If the diverticulum was surrounded by omentum, or was adherent to the pelvic peritoneum, a peri-rectal abscess or a retroperitoneal abscess develops. If the infection in the diverticulum is acute, and previous inflammatory process has been absent, the diverticulum occasionally ruptures into the free peritoneum, with a resulting generalized peritonitis. Mummary[4] reports three such cases, and T. Warwick[5] reports two others. I have knowledge of such a complication, from which the patient died of a general peritonitis. If, as in most instances, the infectious process is chronic and repeated attacks of inflammation occur, with or without abscess formation, a chronic inflammatory thickening occurs in the colon, usually the sigmoid, which is hard and more or less fixed. The bowel in this region becomes narrowed by scar tissue, and a stenosis occurs which may lead in unusual cases to obstruction of the bowel. The relation of carcinoma to the development of diverticulitis is not clear. There are those who believe that a tendency for carcinoma to develop in an inflamed diverticulum exists, while others do not. It is certainly true that carcinoma and diverticulitis rather frequently co-exist. In several cases

FIG. 1.—Case I. Diverticula of descending colon in a patient who had a sigmoidovesical fistula.

I have seen at operation, the carcinoma was in no way different from that developing in a noninflamed colon.

The symptoms of diverticulitis naturally depend on the inflammatory and infectious processes taking place in the diverticula, and vary from chronic spastic colitis with constipation to perforative pericolitis with pelvic abscess, retroperitoneal abscess, bladder fistula, acute perforative peritonitis, or chronic stenosis of the colon with an inflammatory tumor. The most frequent manifestations are recurrent attacks of abdominal pain in the lower abdomen, and gas distension associated with constipation. Blood may be present in the stools (18 per cent., Judd), occasionally pus is present in the stools, while

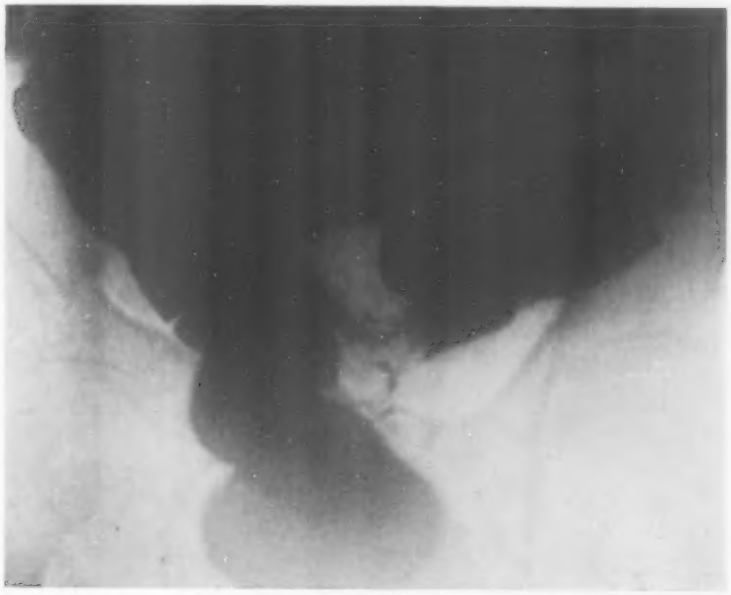

FIG. 2.—Case I. Sigmoidovesical fistula with filling defect in the sigmoid from chronic diverticulitis.

excess of mucus is common. If the inflamed diverticulum is near the bladder, frequency of urination and burning urination is present. If the inflammatory process attaches itself to the bladder, pus in the urine is present. If the diverticulum ruptures into the bladder, gas and feces pass from the bladder on urination.

The diagnosis of the presence of diverticulosis is made not only on the history and physical examination of the patient, but by X-ray examination of the colon. In uncomplicated cases one has but to think of the possibility of these lesions to diagnose them. If the bowel wall is sclerosed by scar tissue, or a great amount of inflammatory reaction is present about the bowel, the diverticula may not fill, and only a filling defect of the bowel will be seen in the X-ray plate. In most instances a characteristic filling of the diverticula is seen; associated with their filling is a marked spasm of the colon which greatly exaggerates the haustra and gives the bowel the appearance of a

partially closed accordion. Proctoscopic examination should be made, but rarely is helpful. If a fistula is present barium may be seen running outside the bowel, or barium may be found in the bladder urine.

The differential diagnosis is by no means easy in complicated cases, where the thought of carcinoma of the sigmoid is ever present. Where diverticulitis of the colon has resulted, by reason of recurrent inflammation, in a narrowing of the colon, with or without an inflammatory tumor, accompanied by blood in the stools, the diagnosis may only be made by exploratory operation and, rarely, only by microscopic examination of the excised bowel. In attempting to marshall the facts in favor of such a lesion being due to diverticulitis, the time element is very important and the knowledge of the existence of the lesion over a number of years may make the diagnosis (Cases III and VIII). Diverticulitis is characterized by the intermittency of its sypmtoms; the passage of bloody mucus and pus in the stool is much more prominent in the history of carcinoma than in diverticulitis. The diverticulitis patient is in relatively better health and has no cachexia, or progressive loss in weight. Fever and leucocytosis is more common in diverticulitis. The presence of a sizable tumor mass in the sigmoid speaks more for diverticulitis than carcinoma, where the lesion is circular and not easy to palpate until late in the disease. The early appearance of chronic obstruction of the bowel is more characteristic of carcinoma. The X-ray examination of the colon showing a filling defect in the bowel, by weighing of detail, may be helpful in these doubtful cases, but is not usually decisive even though diverticula may be seen above and below the filling defect. In the most puzzling cases exploratory operation must be done, for when carcinoma comes seriously into question an immediate solution of the problem is imperative.

In patients developing a sigmoidovesical fistula a number of possibilities, as to cause, arise, though it must be said that diverticulitis is the most common. Carcinoma of the upper rectum and at the rectosigmoidal junction very commonly attaches itself to the base of the bladder, and late in the progress of the disease may rupture into the bladder, with the formation of a sigmoidovesical fistula. The differentiation between carcinoma and diverticulitis under these circumstances may be most difficult, if not impossible. In carcinoma the progressive tendency of the disease contrasted with the intermittency of the symptoms preceding the rupture is important. The more constant and earlier appearance of the blood and pus in the stools again speaks for carcinoma of the bowel. Where carcinoma is suspected at the rectosigmoidal junction proctoscopic examination may make the diagnosis, though frequently the lesion is just "around the corner" from the end of the proctoscope, due to fixation and narrowing of the bowel. Digital examination will reveal a mass in the cul de sac, which is harder and less sensitive than the pelvic mass found in diverticulitis (Case IV). Cystoscopic examination is of great value, for not only is carcinoma of the bladder usually excluded, but the site of the fistula may be seen. If it is small it is most likely to be from a diverticulitis of the colon. If it is large and an ulcer, carcinoma of

the bowel or bladder is usually the case. Biopsy of the suspicious tissue may make the diagnosis. This is not without risk, and may greatly increase an inflammatory reaction in the mass around the diverticulum, (Case VII).

Carcinoma of the bladder rarely perforates into the intestine. A diverticulum of the bladder may become infected and result in a pelvic cellulitis, but rupture into the bowel is rare, and results most commonly from operative procedures.

Tuberculous peritonitis, with abscess formation, frequently results in fistula formation after the abscess has ruptured through the abdominal wall or into abdominal viscera. In the latter instance the bladder may become involved in an enterovesical fistula (Case V). In such an instance the previous history and onset of the disease is usually sufficient to made a diagnosis.

FIG. 3.—Case VII. Filling defect of sigmoid with sigmoidovesical fistula. Multiple sigmoid diverticula.

Carcinoma of the ovary, especially papillary carcinomatous cysts, may involve both the bladder and the bowel, resulting in a fistulous communication between the two.

Chronic infection of the tubes, with induration and long-standing abscess not infrequently causes a sigmoidovesical fistula. Tuberculosis of the tubes may also be responsible for such a condition.

Rarely, actinomycosis of the large bowel, echinococcus disease of the mesentery or pelvic organs may cause fistulous communication between the bladder and bowel. The diagnosis of the cause of fistula in these instances is not usually made except by operation or autopsy.

Traumatic lesions, either from gunshot wounds, fracture of the pelvis, or from operative procedures in the pelvis, may result in sigmoidovesical fistulæ, but here the causative factor is known.

The treatment of diverticulitis obviously depends on the secondary inflammatory changes taking place. If the symptoms are merely those of spastic colitis with attacks of annoying pain and gas formation, the patient should be given a diet rich in cellulose vegetables and cooked fruit to promote easy elimination without the use of cathartics or enemata. Rather continuous

use of paraffin oil by mouth is helpful. Calcium salts which predispose to fecalith formation should be avoided, as should bran, seedy fruit and vegetables. Small doses of belladonna may be helpful in controlling spasms of the bowel.

If an inflammatory mass develops, rest and a moderate degree of

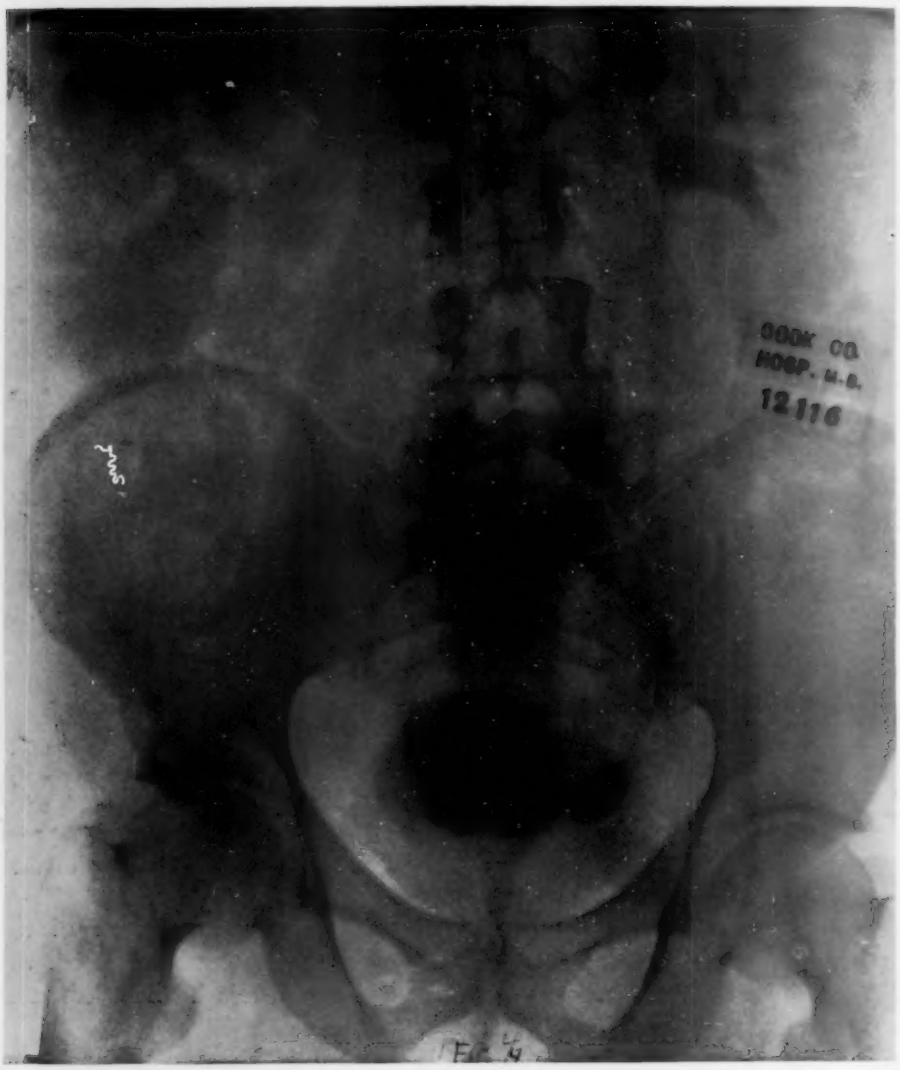

FIG. 4.—Case VIII. Sigmoidovesical fistula. X-ray showing stones in bladder and pyelogram of left kidney.

expectancy may result in its disappearance, but in such a condition a temporary colostomy above the mass may be necessary. Resection of the involved bowel may have to be done later, but with sidetracking of the fecal stream by colostomy these inflammatory tumors often subside.

If stenosis of the bowel results, preliminary colostomy followed by resec-

tion of the diseased segment of the bowel may be necessary. Resection may be done by the Mikulicz graded method, or by other accepted methods. Mummary resected the bowel in nine cases, with two deaths. He performed colostomy in fourteen cases. Rowlands [6] reported fourteen resections, four of which were done because of the belief that the lesion was carcinomatous.

FIG. 5.—Case VIII. Sigmoidovesical fistula. Spastic colon.

In acute cases where abscess has formed the abscess must be drained. In acute perforative peritonitis immediate operation with attempt to close the source of the infection must be carried out.

In fistulæ between the bladder and the large bowel due to diverticulitis treatment must depend upon the severity of the symptoms. (*a*) If the process is acute, with marked cystitis and evidence of ascending infection, a colostomy should be done and the bladder drained by an indwelling catheter until the

acuity of the condition subsides, (Case VI). (*b*) In patients with an inflammatory mass between the bladder and the bowel, and the symptoms not being acute, expectancy may be tried with the hope that under rest the mass will subside, (Case VII). (*c*) Where the fistula is a chronic process and no acute symptoms are present a laparotomy should be done and the communication

FIG. 6.—Case VIII. Sigmoidovesical fistula. Cystogram showing potassium bromide present in bladder and sigmoid.

between the bladder and the bowel separated, with layer suture of each viscus. Temporary colostomy is also usually indicated (Cases VI and VIII). (*d*) In old persons who have had a small sigmoidovesical fistula for years, and the urinary tract has gained tolerance to fecal contamination operation may be deferred (Case VI).

CASE REPORTS.—CASE I: *Rupture of abscess from diverticulitis of the sigmoid into the rectum.*—Mr. A., aged fifty years. The patient has had intermittent attacks of cramp-like pain associated with gas formation in the lower abdomen for several months. A week before entrance into the hospital he had a chill, followed by temperature; developed soreness in the lower abdomen, followed by the passage of a considerable amount of blood and pus from the rectum. Proctoscopic examination revealed an inflamed area above the prostate on the anterior side of the bowel from which a small amount of pus was escaping. After these symptoms had subsided, X-ray examination revealed multiple diverticula of the sigmoid.

CASE II: *Retrosigmoidal abscess, probably due to diverticulitis of the sigmoid.*—

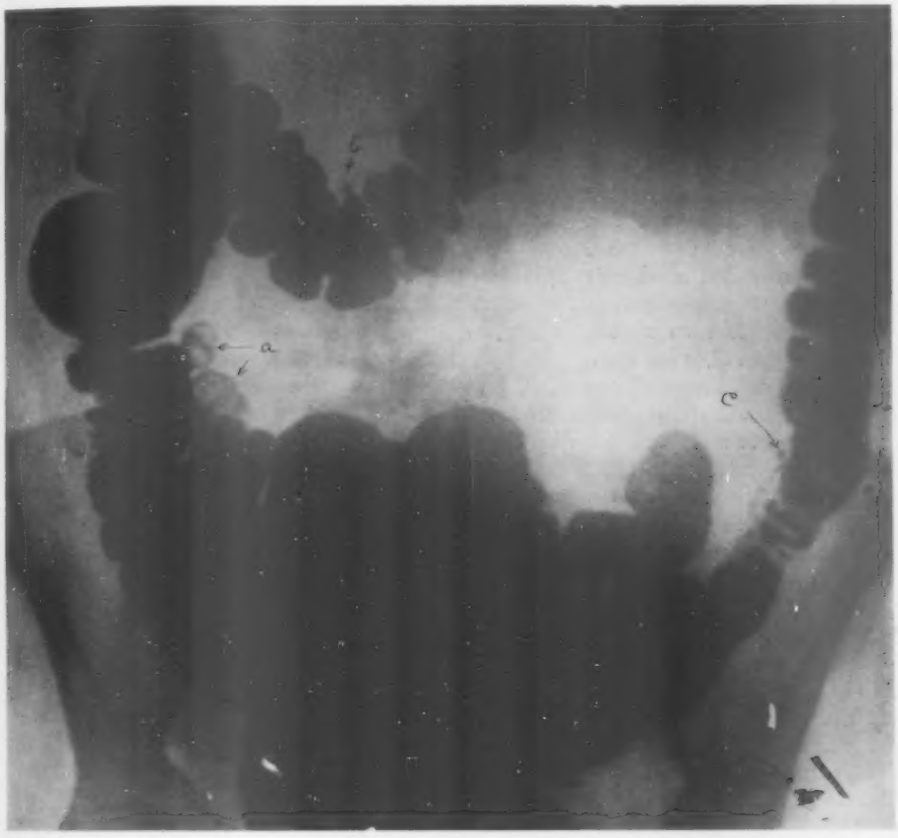

FIG. 7.—Diverticulitis of cæcum (*a*), transverse colon (*b*) sigmoid (*c*). Acute abscess formation around cæcal diverticula.

Mrs. T., aged fifty-six years, seen with Dr. R. C. Brown and Dr. W. C. Danforth. Patient had had an irritable bowel for several years; the present illness started with a chill, high fever, and pain in the lower left abdomen toward the flank. In the succeeding ten days a mass developed just above the brim of the pelvis on the left side. A temperature of 101° to 102° F, and a leucocytosis was present. The urine was negative. By fluoroscopy the mass lay behind the sigmoid and apparently contained gas. An incision in the flank encountered foul pus, retroperitoneally just behind the sigmoid. The kidney was not exposed. While it could not be proven, the probability was that the abscess resulted from a diverticulitis.

CASE III. *Long-standing sigmoidovesical fistula.*—Mr. R., aged sixty-nine years, seen with Dr. H. R. Kretschmer. History of passage of gas and feces with urine for

twenty-five years. Cloudy urine, frequency, nocturia, occasional chills and fever for three years; occasional blood in the stools. Onset twenty-five years ago with a perirectal abscess, which finally ruptured spontaneously. At that time he passed pus in the urine and ever since has passed some gas in the urine. Cystoscopy by Doctor Kretschmer showed feces in the urine, and an opening in the upper left quadrant of the bladder was present, which seemed to connect with the bowel. Fluoroscopy of the colon showed multiple diverticula and a filling defect one inch long in the lower sigmoid loop (Fig. 2). In the descending colon and splenic flexure there were multiple diverticula. Because of the age of the patient, the long-standing fistula, the lack of progressive symptoms, and the probability of the necessity of resection of the bowel due to stenosis (Fig. 1), he was advised to postpone operative treatment.

CASE IV: *Long-standing sigmoidovesical fistula from carcinoma of the rectosigmoid, which very closely resembled diverticulitis.*—Mr. R., aged fifty-nine years, seen with Dr. H. L. Kreschner. History of increasing constipation, necessitating cathartics, flatulence and cramp-like pains in the lower abdomen has been present for three months. Pain in the suprapublic region had been present for two weeks. No blood had been noticed in the stools and there were no urinary symptoms. Examination revealed gurgling noises in the colon, tenderness and muscle spasm over the suprapublic region. Rectal examination revealed a mass in the cul de sac outside of the rectum. The prostate was normal to palpation. Cystoscopic examination by Doctor Kretschmer showed a protrusion into the bladder from the outside.

October 1, 1926.—Operation by Doctor Kretschmer. Midline incision, peritoneum opened for exploration showed large bowl firmly adherent to posterior bladder wall. Peritoneum closed, cystotomy done. A red, swollen area about 6 centimetres in diameter over the area of protrusion into the bladder was found. Pressure made on the mass protruding into the bladder resulted in foul pus being expressed from an area about the size of a pinhead in the bladder mucosa. I was asked to see the patient during the operation and at that time both K and D thought the condition was due to a rupture of a diverticulitis into the bladder. Suprapublic drainage was instituted.

October 4, 1926.—Rectal examination showed mass in cul de sac nearly gone.

October 11, 1926.—Bowels moving, abdomen soft. Above the prostate the finger can just touch a rounded mass.

November 16, 1926.—Gas is being passed through the urethra. Patient runs a low-grade temperature. Suprapublic opening closing. Patient went home.

February 1, 1927.—Patient returned, with burning urination and passage of gas and feces in the urine. Blood clots were present in the urine. Running a low-grade temperature and losing weight. The mass in the cul de sac is harder and larger. Fluoroscopy of the colon shows a filling defect in the rectosigmoid, and sodium iodid placed in the bladder runs into the bowel. We began to doubt the diagnosis of diverticulitis and think more of carcinoma.

March 16, 1927.—Because of infection of urinary tract a colostomy was performed under local anæsthesia. A hard mass was felt in the pelvis.

May 16, 1927.—Patient died. Anatomical diagnosis, carcinoma of the rectosigmoid. Suppurative carcinomatous infiltration of the pouch of Douglas and the wall of the urinary bladder. Fistulous tract between the rectosigmoid and the urinary bladder.

CASE V: *Tuberculosis of the bladder and peritoneum and a sigmoidovesical fistula.*—Mrs. E., aged fifty-six years, seen with Dr. H. L. Kretschmer. Entered the hospital March 21, 1924, with a history of six years duration of cystitis, associated with some discomfort in the lumbar region. Cystoscopy by Doctor Kretschmer, showed an ulcer of the bladder the size of half a dollar. Biopsy revealed tuberculosis. The ulcer was then excised.

August 25, 1925.—Returned with cystitis and blood in the urine; in the dome of the bladder was a large white ulcer with a necrotic base. This area was dissected by Dr. K. *Pathological diagnosis,* tuberculosis.

November 16, 1925.—Patient nauseated and vomiting.

February 13, 1926.—Feces and gas discharged from bladder through the cystotomy wound.

April 22, 1926.—Colostomy advised by D. to sidetrack fecal stream. Left rectus incision revealed peritoneal cavity obliterated by firm, fibrous adhesions. The large bowel could not be identified. A right muscle splitting incision, cecostomy was performed.

June 5, 1926.—Patient died. Anatomical diagnosis, tuberculosis of the left kidney. Extensive pelvic tuberculous peritonitis. Fistula between urinary bladder and sigmoid. Ascending pyelonephritis.

CASE VI: *Sigmoidovesical fistula.*—Mr. X., aged fifty years. History of cramp-like pains and gas formation in the lower abdomen over a period of several months. Two weeks before entrance to the hospital acute abdominal pain with fever, followed by passage of gas and feces into the bladder. Cystoscopy showed a small opening in a diverticulum of the bladder, from which gas escaped. Colostomy performed by Doctor Bevan. Subsequent laparotomy with separation of the bowel and bladder.

CASE VII: *Sigmoidovesical fistula from diverticulitis. Abscess in right hypochondrium from diverticulitis.*—Dr. J. K., aged forty-five years, seen with Dr. H. L. Kretschmer. Present complaint, passage of gas and feces in the urine, with symptoms of cystitis. This condition began six weeks before entrance to the hospital (November 24, 1925), and followed an attack of constipation at which time he took a cathartic and an enema, which resulted in marked abdominal cramps and several stools. The passage of gas and feces in the urine continuing, the patient had several examinations at various clinics, where various diagnoses were made. At one clinic a piece of tissue from the region of the fistula in the bladder was excised through a cystoscope, and a diagnosis of papillary carcinoma of the bladder was made. Cystoscopy by Doctor Kretschmer showed an œdematous bladder mucosa, and at the base of the bladder behind a median bar, in an area of œdema and inflammation, a dark opening was seen which looked like a fistulous opening. A piece of tissue excised from this region showed chronic inflammation. Following biopsy the patient had bloody urine and bladder pain, followed by the development of a mass in the suprapublic region, accompanied by fever of 101° to 103° F. for about ten days. During this time we were on the verge of performing a colostomy, but at the patient's urgent request we refrained. The symptoms gradually subsided and the mass decreased in size, but has persisted until the present time. Proctoscopic examination was negative, a fluoroscopic examination of the colon showed multiple diverticulitis of the sigmoid and transverse colon. (Fig. 3.) Although the sigmoidovesical fistula was still present, the patient left the hospital, but returned August 21, 1926 with pain in the upper right abdomen and a palpable mass just below the costal arch. This mass increased in size and was accompanied by fever. An abscess was diagnosed, and under gas September 1, 1926 an incision was made over it and pus was encountered under the fascia of the external oblique. The pus was found to exude through an opening in the muscle which entered the abdomen. This abscess was undoubtedly due to a diverticulitis in the transverse colon. At the last examination the fistulous tract into the bladder still persisted, and the patient was advised to have a laparotomy for its repair, which up to the present date he has refused to have.

CASE VIII: *Sigmoidovesical fistula from diverticulitis of the colon.*—Mr. B., aged fifty-six years, entered Cook County Hospital June 14, 1928, with a history that eight years before he had symptoms of cystitis and passed blood and feces in the bladder urine. These symptoms persisted and five years ago were complicated by a mass which developed in the left lower quadrant, varied in size for about a year, until it was opened when a large amount of pus and feces escaped. A fecal fistula has persisted. In addition to gas and feces in the urine, the patient has noticed that he passes urine with the feces. Cystoscopic examination revealed a markedly inflamed bladder containing three bladder stones, and turbid, fecal-smelling urine. (Fig. 4.) The opening of the fistula could not be seen. X-ray examination of the colon was unsatisfactory. (Fig. 5), due to the fact

that the patient could not retain the enema, and obstruction seemed to be present in the sigmoid. No diverticula were seen. On July 9, 1928, I opened the abdomen through a mid-line incision and found a markedly chronic, pelvic adhesive peritonitis uniting the large bowel to the base of the bladder. The adhesions were separated, the left ureter was identified, and the sigmoidovesical attachment was found to be one inch above the left ureterovesical junction. The bowel and the bladder were separated and a three-layer inverting suture was placed in both viscera. The laparotomy wound was then closed with a small iodoform gauze wick in a split tube reaching down to the depth of the peritoneal cul de sac. The bladder was then opened, the three stones removed, and a permanent cystotomy performed. The operation lasted one and a half hours, and the patient left the operating room in good condition. He did well for three days, when he suddenly developed a bilateral bronchopneumonia and died in thirty-six hours. There was no urinary or fecal discharge from the abdominal wound, and the abdomen remained soft.

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ACUTE PERFORATED ULCERS OF THE STOMACH AND DUODENUM *

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FROM THE SECOND SURGICAL DIVISION OF THE NEW YORK HOSPITAL

Herewith are recorded 142 cases of Acute Perforated Ulcers of the Stomach and Duodenum operated on by Doctor Pool, or his associates, at the New York Hospital. In Annals of Surgery, October, 1922, fifty-nine cases were reported by the author of this article in conjunction with Doctor Pool, and these patients are included in this tabulation with the records brought up to date. A statistical report is given, the mortality analyzed, and the follow-up results noted in detail. The literature has been investigated and an effort made to furnish some data that might serve as an aid in the cure of this dangerous lesion.

As one reads the reports from various clinics and peruses the voluminous pages of statistics, one is apt to attempt a classification, to evolve a standard. An attempt is made to have a set procedure for a given pathological lesion. But herein lies the fallacy—the lesion is not a standard condition, but one occurring in a human being, and the process is a relative one. There is nothing absolute; but with a thorough notion of the possibilities one is more apt to have the proper method to apply to the given case. And so the discussion goes on, and some clinics are wed to simple suture of perforations while others feel that the primary gastroenterostomy is necessary. In this difference of opinion it is evident from the records that early diagnosis plus immediate operation means low mortality in spite of the procedure. Study the mortality records of any clinic and it is found that the death rate is directly dependent on the time elapsed from the perforation to the time of operation. For a long time the much mooted question has been simple closure *versus* closure plus primary gastroenterostomy. Again let it be emphasized that both procedures yield low mortality where the operation is performed under six hours.

In this series of 142 patients there were 138 males and 4 females, with a mortality of not quite 22 per cent. In analyzing the cases that died it was found that the most important factor was the time elapsing between the perforation and the operation.

Under six hours there were 94 cases with 7 deaths, or a percentage of 7 21/47 per cent. Between six and twenty-two hours there were 32 cases with 11 deaths, a rate of 31¼ per cent. Over twenty-two hours, there were 16 patients with 13 deaths, a percentage of 81¼ per cent.

As to the cause of death, 24 died of general peritonitis, 5 died of pneumonia, 1 of pulmonary embolus, 1 of multiple abscesses of the liver. It was noted that of those who perforated after eating, those who had been given

* Read before the New York Surgical Society, October 9, 1929. See page 1039.

brisk purgatives immediately after perforating were more apt to have a larger extravasation of gastric contents into the peritoneal cavity and a more fulminating peritonitis with graver complications and more unfortunate results. This again suggests that one beware of cathartics in acute abdominal conditions. Those who perforated with an empty stomach had very little escape of fluid and the prognosis was more favorable. To combat this 22 per cent. mortality in the series three things might be suggested: 1, Early diagnosis; 2, Nothing by mouth; 3, Early operation.

The next important cause of death was from pneumonia. Five patients died of pneumonia. This condition has been the cause of many deaths in simple, uncomplicated conditions—as a pneumonia following a simple appendectomy or a herniotomy—and a considerable amount of study and investigation has been done with the idea of determining the primary etiological factor and eventually eradicating pneumonia from the list of complications. On the Second Surgical Division there has existed a pneumonia prophylaxis committee for a good many years and the function of this committee has been to investigate this disease from every angle. The type of patient, his home surroundings, his normal habitat and routine, his daily garments, his sleeping apparel, the ventilation of the ward, the avoidance of drafts, the bacterial examination of the buccal contents, the sera preventative therapy, the care of the patient in transportation, the type of anæsthesia, the proper coverings—these and other factors were considered and an effort has been made to see that the patients experience as little change of environment or dress as possible. After operation those developing colds were carefully studied; chest X-rays, sputum, cultures, etc., in an attempt to lower the incidence of pneumonia. With all these aids it was also found that with the introduction of ethylene anæsthesia there was a marked reduction of the pulmonary complications.

In a study of the gastric cases it was found that the pulmonary complications were higher than in lower abdominal surgery. In the last 32 cases in this series there were 13 pneumonias with three deaths. It is interesting to note that two of the most recent perforations have been done under spinal anæsthesia, one of the patients developing a post-operative pneumonia, the other an abscess of the wound. There was one pulmonary abscess in the series, and one case developed multiple abscesses of the liver.

Attempting to associate the disease with certain definite factors it was found that the season of the year had little influence on the disease. The youngest in the series was eighteen years, the oldest sixty-nine years. Men perforated much more frequently than women. Race, color, creed, all alike were visited by the affliction and neither rich nor poor were spared.

Naturally, in a study of this kind an effort was made to discover the causative factor—an ulcer, a lesion in which the processes of degeneration are slightly in excess of those of regeneration. As in most ulcers the cause may be local, as from trauma, chemical insult, thermal affront or bacterial invasion. The cause may be general as in some constitutional disease but, most prob-

ably, it is the combination of both a constitutional disorder plus a local condition. The more one sees of this disease and the more one studies these patients, the more one is impressed with the associated nerve involvement in these ulcer cases. Patients well and free of symptoms for weeks, months and years have some sudden nervous upset—a financial loss or some family worry—and the symptoms recur; severe pylorospasm, excessive gastric secretion, gastric heaviness, uneasiness, discomfort and pain. Turn these patients out into the country, relieve their anxieties and many of them are relatively well again.

The majority of these patients gave a history of gastric distress for some months or years prior to operation, while others were certain the initial symptom was the perforation. In talking to these patients the alcoholic history was most carefully considered and it was ascertained that most of them were not alcoholic in habit.

The history of acute agonizing pain with a restless patient tossing from side to side, with knees and thighs flexed, breathing short costal breaths and appearing seriously sick clinches the diagnosis. The patient looks like a wounded animal and the initial picture is of inhibition, of a person trying to protect himself. Subnormal temperature, slow pulse, costal breathing, low leucocytes, a picture of holding everything—inhibition. This is the time to diagnose, the time to operate. The subsequent picture is generally one of peritonitis.

Procedure.—In less than an hour after admission most of these patients were operated on, ethylene-ether being the anæsthesia of choice. A high right rectus incision and a simple closure of the ulcer with drainage to the peritoneum. In 10 of the 142 cases a primary gastroenterostomy was done because the operator felt the lumen of the pylorus had been obstructed. Two of the cases reperforated and had a gastroenterostomy at the second procedure. None of the cases with primary gastroenterostomy died. After operation the patients are placed in bed and the following instructions serve as a guide for the routine care. However, it must be definitely understood that each case is different and must be treated as such. The diet is but a guide.

First Post-operative Day.—Water, 1 dram every half hour.

Second Day.—Water, ½ ounce every two hours alternating with peptonized milk, ½ ounce every two hours.

Third Day.—Water, 2 ounces every two hours alternating with peptonized milk, 2 ounces every two hours.

Fourth Day.—Water, 4 ounces every two hours alternating with milk, 4 ounces every two hours.

Fifth Day.—Water, 4 ounces every two hours alternating with milk or egg nog, 4 ounces every two hours.

Sixth Day.—BREAKFAST: Cereal with cream and small amount of sugar. One cup cocoa. TEN A.M.: Egg nog. DINNER: Cream soup, soft boiled egg with softened toast. THREE P.M.: Egg nog or milk. SUPPER: Milk toast, custard. EIGHT P.M.: Cocoa or milk.

Seventh Day.—BREAKFAST: Cereal with cream and sugar. One cup cocoa. TEN A.M.: Egg nog. DINNER: Cream soup, baked potato with butter, milk, 6 ounces. TWO P.M.: Milk or egg nog. SUPPER: Milk toast or soft boiled egg, custard. EIGHT P.M.: Cocoa or milk.

Eighth Day.—BREAKFAST: Cereal with cream and sugar, one soft boiled egg, one slice toast, cocoa or milk. TEN A.M.: Egg nog. DINNER: Cream soup, baked potato with butter, custard, milk. TWO P.M.: Egg nog. SUPPER: Milk toast or oyster stew, milk, wine jelly and cream. EIGHT P.M.: Cocoa or milk.

Ninth Day.—BREAKFAST: Cereal with cream and sugar, one soft cooked egg, one slice toast, cocoa or milk. TEN A.M.: Egg nog. DINNER: Cream soup, baked potato with soft cooked egg, wine jelly with cream, milk or cocoa. SUPPER: Milk toast, custard, cocoa. EIGHT P.M.: Egg nog or milk.

Tenth Day.—BREAKFAST: Six prunes, cereal with cream and sugar, one soft cooked egg, cocoa. TEN A.M.: Egg nog. DINNER: Cream soup, scraped beef on toast, custard, milk. TWO P.M.: Egg nog. SUPPER: White meat of chicken, toast, wine jelly, milk. EIGHT P.M.: Cocoa or milk.

Eleventh Day.—Add green vegetables.

Primary gastroenterostomy was done in 11 cases and secondarily in 10 cases, or 21 in all.

Follow-up.—One hundred and eleven patients were discharged after operation and 103, or 92 88/111 per cent., have been followed. These patients are never discharged from the follow-up clinic and are seen quite frequently as symptoms warrant by one man who makes a particular study of these cases, carefully analyzes the symptoms, advises as to diet, etc. Most of these patients have been fluoroscoped since operation and many X-rays taken to study the post-operative condition. The post-operative picture generally shows a slight distortion at the site of perforation. In seeing these patients, in painstakingly listening to their stories one cannot but be impressed with the important part the nervous system plays in this disorder. A patient is well, free of symptoms, gaining in weight. Some misfortune occurs, the patient is upset, and the gastric story begins again. Uncomfortable heavy feeling in the epigastrium, inability to concentrate, restlessness, yawning, these are the signs and the patient consults the doctor. Fluoroscope this patient and a marked pylorospasm is found and, in some cases, it lasts from two to three days. Relieve the nervous condition, set the patient aright, the pylorospasm yields and hypermotility recurs because it has been found on examination that these patients have hypermotile rather than hypomotile gastrointestinal tracts. The condition disappears and the patient is well for months, for years. It may be the only attack. Fluoroscope this patient a week after the attack and a normal stomach and duodenum is observed, with no spasm, no retention. This suggests definitely that in the recurrence of symptoms one should not be too ready to operate. Give them a chance. An effort has been made to get close to these patients, win their confidence and let them feel that one is anxious to help. With this notion in mind a short talk is given to each patient before leaving the hospital.

In these stomach cases the question of post-operative therapy is paramount and, while the etiological factor in the production of ulcers has not been

determined, it is known that they are generally associated with an increase in the acid content, notably an increase in free HCl. The nervous, high-strung individual facing a crisis, going through some unusual mental effort is generally the ulcer type that perforates. Whether the etiological factor be bacteriological, parasitic, embolic, chemical, thermal or mechanical, the thing to be remembered is that most of these patients have an increased acid content with hypermotility of the stomach and the intestines; there is a constitutional plus a local cause. The pain and discomfort are due to increased acid plus tension. The constant nerve reflex from the stomach causes increased activity of the smooth muscle with tightening of the pyloric sphincter and constant effort on the part of the stomach to drive its contents on causes the severe pain and spasm at the pylorus. It is a question of tension. These patients are not as a rule constipated but, if anything, hyper-active. The peristalsis is increased, not diminished, and it is this constant nerve stimulation that causes the pylorospasm, shutting down of the pylorus and the accumulation of acid with subsequent gastric fermentation that causes distress. The gas accumulates, the stomach dilates, the tension is increased and the patient resorts to all sorts of charged water, vichy, etc., to try to "belch." Belching gives great relief. Here then is the crux of the whole situation. The enumeration of cases, the careful steps in technic, can all be standardized but the important thing is that each case is an entirely different clinical entity and must be treated as such. The large atonic stomach in the nervous, sensitive individual is the condition to be treated. Therapy —as the etiological factors are probably (1) constitutional and (2) local so the treatment must be (1) constitutional and (2) local.

Take the nervous, high-strung individual, turn him out to grass, remove his worries, solve his economic difficulties and an excellent start has been made. Many of these stomach cases are perfectly well for a long period but as soon as they lose their mental poise, some accident, some shock, down they go and the trouble begins. Fluoroscope this patient and one finds the severe pylorospasm, hypermotility, increased tension. Mental rest, careful coaching and they are well again almost immediately and the symptoms are gone for years, maybe forever. In the study of these cases here is where the progress has been made. Each patient before he or she leaves the hospital is given careful instructions as to hygiene and to diet. Not a mere form without reasons, but a list is given and intelligently discussed. The talk would go as follows:

"You have had a severe condition, an ulcer of the stomach and it means you must be always careful as to your habits, diet and exercise. It is most important for you to keep in contact with some intelligent physician to advise and coach you. That is what you want, a coach, not necessarily a doctor. Someone to whom you can talk, discuss your troubles. No one knows definitely what causes ulcers but they generally are found with an increase in acid. The stomach is large, becomes filled with food that decomposes and then gas is formed. Be very careful in taking your food, wash

the hands and rinse the mouth to get rid of all bacteria. Take time to eat, sit down and chew the food, remembering that the food should be broken up in the mouth, mixed with the salivary juices and prepared for entering the stomach, so that the food does not drop in the stomach as a lump of lead. Try not to mix liquids and solids nor take a large amount of water at the meals as they just fill up the stomach and make it atonic. This is the cardinal principle. *Never* have the stomach 'empty.' *Never* have the stomach 'filled.' This means frequent small meals a day throughout the day. Eat at two- to three-hour intervals. The need of frequent feeding is quite evident in treating gastric cases. They acquire a dread of food, lose weight and resistance.

"On arising, if possible, drink a glass of warm milk to counteract the acid that may have accumulated during the night."

AT 8:00 A.M. BREAKFAST.—*Simple plain foods.*

A. Any kind of stewed or cooked fruits. Avoid oranges, grapefruit or any raw fruits.

B. Cereal with milk or cream, gruel, oatmeal, cornflakes, bran, puffed rice, shredded wheat.

C. Eggs—poached, boiled, scrambled. Not fried.

D. Toast or rolls with butter.

E. Coffee, one cup.

Drink no water with meals.

TEN A.M.—Glass of milk with a cracker or piece of bread.

Just about this time most of these patients begin to feel empty in their stomachs; they have no pain, but are conscious of their stomach, begin to yawn and to get quite restless. It is amazing how a small amount of food puts them right back on their feet. For a long while milk alone was advised or soda bicarb. but neither stays long enough in the stomach. The addition of some small solid matter means the food stays longer and acts like a soothing dressing to a weeping stomach. "Drink small amounts of water at a time between meals."

NOON.—*A.* Soup—chicken or cream soups only, as the beef extractives, consommé, etc., tend to stimulate gastric secretion.

B. Fish—almost any fish.

C. Entrées—steaks, not well done, roast beef, pot roast, lamb chops, chicken, veal—small amounts. Foods fried in grease should be avoided.

D. Potatoes—boiled, mashed, baked. Not fried.

E. Vegetables—spinach, string beans, beets, peas, cauliflower, asparagus. Avoid onions.

F. Dessert—custard, puddings, ice cream, small piece of plain cake.

One cup of tea.

Drink water in small amounts between meals.

THREE-THIRTY P.M.—Milk and crackers.

SEVEN P.M. DINNER.—Meat, bread and butter, potatoes, vegetables, one cup of coffee.

NINE-THIRTY P.M.—Milk and crackers.

This gives a wide latitude and from observing each case one finds that certain things are good for A and bad for B, and *vice versa*. That is the

idea of the doctor or coach to check up on the diet list. Alkalies should be encouraged at all times. Alcohol prohibited.

Food fried in grease forms a bolus that slips into the stomach. It is hard for the gastric juices to penetrate this bolus and the food lies there, a heavy, undigested mass.

If the patient awakes at night and has any discomfort, take either a glass of milk, if accessible, or soda bicarb. in water.

The teeth should be put in perfect condition and a dentist seen at least every six months.

When possible, rest for fifteen minutes to one-half hour after eating. Have bowels move freely. Never eat when nervous or excited.

This routine of coaching, advising, helping the patients has done much to make the results in gastric surgery much more satisfactory.

ONE-HUNDRED AND FORTY-TWO CASES OF ACUTE PERFORATED ULCERS

Tabulated Statement

Cases		142
Deaths (31 59/71 per cent.):		
G. P.	24	
Pneumonia	5	
Pul. Embolus	1	
Mult. Abscess Liver	1	
	—	31
Color—Negroes		3
Sex:		
Male		138
Female		4
Mortality:		
94 cases under 6 hours—deaths (7 21/47 per cent.)		3
32 cases between 6 and 22 hours—deaths (32 1/4 per cent.)		11
16 cases over 22 hours—deaths (81 1/4 per cent.)		13
Primary Gastroenterostomy—6 3/71 per cent. (average time 3 3/4 hours perforation)		10
Primary Pyloroplasty		1
Secondary Gastroenterostomy		10
Follow-Up:		
Discharged		111
Followed		103
Results:		
Well without symptoms since operation:		
Without Primary Gastroenterostomy	77	
With Primary Gastroenterostomy	5	
With Pyloroplasty	1	
	—	83

Had return of symptoms:		
Without Primary Gastroenterostomy (10 had Secondary Gastroenterostomy)	18	
With Primary Gastroenterostomy	2	
		— 20

SUMMARY

Without Primary Gastroenterostomy:		
Good (81 2/19 per cent.)	77	
Poor (18 18/19 per cent.)	18	
		— 95
With Primary Gastroenterostomy:		
Good (71 per cent.)	5	
Poor (29 per cent.)	2	
		— 7
With Pyloroplasty:		
Good	1	
		—
TOTAL CASES FOLLOWED		103

Simple closure has given good results in a fairly high percentage of cases. Dr. Luis Urrutia, of Madrid, Spain, reporting "Late Results in Perforated Gastro-duodenal Ulcers" in the ANNALS OF SURGERY for July, 1929 (page 73), has extensively referred to the bibliography of this condition and discusses simple closure *versus* closure plus primary gastroenterostomy. His own predilection is for simple closure. At the New York Hospital on the Second Surgical Division simple closure is the method of choice—(1) because there is less risk and (2) because 20 per cent. of all gastroenterostomies done on the division have yielded untoward results. Hence the tendency has been to shun gastroenterostomy where possible.

This series represents many cases followed over a long period. The longest twenty-one years. It emphasizes the following salient points:

1. Early diagnosis with operation under 6 hours yields low mortality.
2. Pulmonary complications are a serious factor in this condition accounting for 16 per cent. of the mortality.
3. Post-operative diet and medical coaching are essential for a long time after operation.
4. Secondary operations should be performed only after a most careful study of the case and a prolonged course of medical treatment.
5. Secondary gastroenterostomy has given excellent results to those requiring further surgery.

THE PHYSIOLOGY OF THE LIVER AND ITS RELATION TO SURGERY OF THE BILIARY TRACT*

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Advances in surgery of the liver, and particularly of the extrahepatic biliary passages, during the last few years have provided new bases for rational treatment of diseases of these organs. As in surgery of the genito-urinary tract particularly, and as in surgery of the thyroid gland, new methods of estimating functional capacity and pathologic injury to the liver and its appendages have made for safer operations with better insight into the risk of operation and the chance of permanent or partial cure. Most significant of all, perhaps, newer methods combined with clinical factors have made for better selection of the time of operation which provides the safest and most expedient avenue for recovery. The last ten years have witnessed the development of most of the important newer facts concerning the physiology of the liver and its adnexa so far as their functions are related to surgery of these organs.

Any study of the liver is complex. Anatomically the liver is of special interest in surgery because it is a single vital organ and because it has a double blood supply. Physiologically it is important because of the multiplicity of its metabolic functions. Pathologically it is important because it is subject to many diseases of infectious, vascular, metabolic and neoplastic origin. Surgically it is important for all of these reasons.

PHYSIOLOGY

Regenerative Function of the Liver.—For many years it has been known that the liver regenerates rapidly after serious injury following chloroform poisoning. Mann has noted similar regenerative phenomena after surgical removal of lobes of the liver. One lobe may be removed and after a few weeks the liver will be as large as before the operation. Consecutive operations for removal of other lobes are followed by similar replacement of tissue. The lobes are not restored, but the remaining lobes increase in size and their edges become rounded. The remaining tissue appears to function normally although it is not able to withstand untoward conditions as well as is normal hepatic tissue. The regenerative tendency may be prevented by experimental short circuit of the portal circulation before lobectomy, by occurrence of biliary obstruction, and by cirrhosis. In this manner the total hepatic tissue may be permanently reduced to as low as 15 per cent. of the normal amount.

* The Trimble lecture given before the Medical and Chirurgical Faculty of the State of Maryland, April 24, 1927.

† Some of the work of preparation of this paper was done by C. Baxter Brown, M.D., Fellow in Surgery, The Mayo Foundation, Rochester, Minnesota.

Under these circumstances the liver appears to function normally if the animal is kept on a carbohydrate diet composed largely of milk and syrup. If proteins are fed, such as in the form of meat, cirrhosis with ascites develops and the animals die.

These facts are emphasized clinically by the known ability of the liver to perform adequately all its functions even in the most marked degrees of disability due to disease which may be either primary or secondary to lesions in the extrahepatic bile passages. It is known clinically and experimentally that the great metabolic functions of the liver are adequately performed when the liver is most seriously handicapped either by disease or experimental surgical destruction of its tissue.

Carbohydrate Metabolism.—Since Claude Bernard called attention to the liver as a storehouse for carbohydrates, our knowledge of this hepatic function has increased. It is known that glucose resulting from intestinal digestion reaches the liver through the portal circulation where it is in part utilized immediately for bodily consumption and is in part stored as the readily accessible compound, glycogen. With any need for glucose, glycogen is hydrolyzed and converted to glucose. Although glycogen is not wholly stored in the liver and comprises a considerable percentage of muscle constituents, the principal storehouse is in the liver. Mann [4] has shown definitely the rôle of the liver in carbohydrate metabolism, by experimental surgical hepatectomy and exhaustive studies of blood-sugar levels under various conditions. Following experimental total removal of the liver, there is progressive hypoglycemia which increases to a point at which definite symptoms appear, followed by convulsions and death. The blood sugar may be restored and the symptoms completely relieved by the intravenous administration of glucose over a period of many hours, when another and different set of symptoms appears, followed by death from another cause. The rôle of the liver in the maintenance of blood-sugar levels is therefore necessary to life. Other substances such as lactic acid and levulose, when administered intravenously, do not cause a rise in blood sugar nor do they defer death as does glucose. During the periods of hypoglycemia, muscle glycogen is measurably reduced; but even at death the amount is sufficient, were it mobilized, to maintain normal blood sugar, thus showing that the synthesis of glucose is dependent wholly on the liver. In cases of depancreatized dogs manifesting hyperglycemia, dehepatization has a similar effect on the blood-sugar level and the clinical course.

Clinical measurement of the carbohydrate metabolism of the liver has been variously made by many workers; the most popular of these methods, the levulose tolerance test, is based on the known fact that in hepatic disease the tolerance to levulose following intravenous administration is measurably reduced. The appearance of levulose in the urine may be taken as a rough measure of injured hepatic function. With newer and finer methods of blood-sugar estimation, more satisfactory results are obtained. Clinically, the test is said to have some practical significance. Mann has shown experimentally, however, that the test is not as reliable as the simple glucose test, and, further-

more, that glucose tolerance tests are not reliable indices of the amount of disease because of the intervention of uncontrolled factors which affect the rate of disappearance of glucose from the blood stream, namely, injury to the pancreas and fasting.

It is evident that the function of the liver in respect to the metabolism of glucose is not shared by other organs and that the necessity of the liver in carbohydrate metabolism is demonstrated. Clinically, however, the methods of demonstrating hepatic injury in respect to the utilization of sugar are so unreliable as to point to the deduction that such injury affects only the reserve capacity of the organ. For this reason, along with the fact that other organs, notably the pancreas, play so important a part in the metabolism of glucose, helpful methods have not been developed for the clinical study of this function in hepatic disease. No doubt, part of this failure may be ascribed to the fact that other methods are available for estimating hepatic injury, which are satisfactory for clinical purposes.

Protein Metabolism.—In a general way it is known that proteins are digested in the intestinal tract to form amino acids which are converted into urea in the liver, and that the urea in turn is excreted in the urine. The measurement of hepatic disease in respect to these processes has not progressed to the point at which accurate and helpful determinations may be made; but from the standpoint of experimental physiology a great deal is known. Bollman and Mann,[1, 3] in a series of experiments with dehepatized dogs, have shown that following removal of the liver the amount of urea in the blood and urine is markedly decreased, and that the amount of amino acids in these fluids is increased. Furthermore, amino acids injected intravenously may be recovered quantitatively from the blood and urine. This shows definitely that deamidization and urea synthesis in the liver are not shared measurably by any other organ, and it may be deduced that, although a good clinical method is not available for the accurate estimation of the injury to protein metabolic processes in hepatic disease, still the significance of the factor in surgical procedures must be considerable. Walters and Parham[17] have shown that following operation on jaundiced patients, hepatic insufficiency associated with abundant drainage of light-colored bile may be the cause of death. In this syndrome marked changes in the urine or blood related to protein metabolism are not present. However, in similar cases there is renal insufficiency secondary to the cessation of drainage of bile in which the level of blood urea rises progressively to the point of uremia. In these cases it is understood that the increases in urea are not due to any abnormality in hepatic function, but to distinct renal insufficiency of toxic origin in which there are definite post-mortem manifestations of the lesions of nephritis. Even when hepatic injury is sufficient to be fatal, enough urea is formed in the liver, so that blood urea is maintained at a normal level. When renal insufficiency is present, the level of blood urea will be raised to that found in uremia. It is evident that the part of the liver in the metabolism of proteins is important and that the liver is probably the sole site of the formation of urea. On the other hand,

the liver is so sufficient for this process that a small portion of it is apparently capable of caring for protein metabolism. At least this is apparent so far as modern laboratory methods are able to demonstrate. It is probably true, then, that any clinical method of measuring hepatic injury from the standpoint of the metabolism of protein will have little value in surgery, but will remain of purely physiologic interest.

It has been suggested by Mann [5] that the measurement of uric acid in the urine at times when patients are on a high purin diet may provide a means of estimating hepatic insufficiency from the standpoint of the protein. This suggestion is based on the fact that after experimental dehepatization, the ability to destroy uric acid is absent; in consequence, relatively large amounts of uric acid are excreted in the urine, and simultaneously the level of uric acid in the blood is increased.[2]

Bile Metabolism.—The significant constituents of bile are the acids, the pigments, and cholesterol. The bile acids, glycocholic and taurocholic, are intimately associated with the digestion and absorption of fats from the intestine. There are no practical methods for estimating the bile acids for clinical purposes, although the Pettenkofer reaction has been employed variously. The absence of the acids in the intestine, as in obstruction to the bile ducts, is the cause of fatty stools; fatty stools serve as a rough qualitative test of the absence of acids. Cholesterol is principally concerned with the formation of gall-stones, and they do not concern surgical procedures except so far as their presence or absence has a bearing on the case.

The metabolism of the bile pigments and their excretion are most important in biliary surgery. The source of bilirubin was a matter of controversy for many decades, until it was shown definitely by Mann and his associates,[6, 7, 8, 9] by means of the spectrophotometer, that this pigment is principally formed in the bone-marrow, and to a lesser extent in the spleen and liver. It seems probable that the tissues most likely to form bilirubin are those containing cells of the reticulo-endothelial system, since they are most numerous in the organs mentioned. There is also histologic evidence of their activity in this respect. Bilirubin, which represents only part of the excretion of the liver, provides the best means of estimating hepatic injury clinically, since this may be measured accurately and easily in the blood serum. The van den Bergh reaction is qualitatively and quantitatively accurate for the pigment in the blood. Duodenal drainage, after the manner perfected by Lyon and Meltzer, is a less accurate measure of pigment excretion, but in cases in which the obstruction is complete, the method is of some significance.

Coagulation Factors.—Delayed coagulation with bleeding in clinical cases of hepatic disease and jaundice is a grave danger and a frequent cause of post-operative death. It has been shown experimentally by Whipple and Hurwitz [18] that injury to the liver of dogs causes marked lowering of the fibrinogen level in plasma. Mann has corroborated this on liverless dogs. Clinically, in diseases of the liver plasma fibrinogen is lowered. Measurement of the coagulation time of the blood in jaundiced patients is a practical

method of estimating one of the elements of surgical risk. The calcium time adds little information since it runs practically parallel with the coagulation time.

Detoxification Property.—The liver probably has other functions, including a detoxifying property which is presumed to protect the organism against bacterial invasion, against the toxins and against certain metallic poisons. There is little dependable, experimental or other proof to substantiate this contention, although certain phenomena point toward such a conclusion. The metallic poisons, for instance, and especially chloroform, when administered in suitable doses, cause focal necrosis of the cells of the liver without injury to other organs, indicating that the liver acts as a protective mechanism for the body. Priestley [11] has shown experimentally by using the heart-lung-liver preparation that the liver has a powerful detoxifying property for strychnine administered in the blood stream. His work shows that many times the lethal dose of this drug will be completely removed from the blood by perfusion through the liver. No accurate or dependable deduction may be drawn from this which is applicable to clinical medicine or surgery, but by inference it may be suspected that the liver has a powerful detoxifying action for other poisons, and possibly for bacteria and their toxins. The question arises whether hepatitis, as seen at the operating table, may not represent residuals of infectious or toxic poisons from which the liver has protected the organism at its own expense. In this respect the marked reserve of the liver is again emphasized, for remarkable degrees of hepatitis are found at operation in cases in which exploration is carried out for other and separate reasons and in which none of the clinical symptoms or findings could be attributed to hepatitis.

Hepatitis.—For a long time we have known that the condition which we describe as hepatitis occurs not only in association with disease of the biliary tract but often when other trouble cannot be recognized. In spite of the fact that we have only rarely been able to isolate bacteria from the liver in these cases, it has been assumed that hepatitis was an inflammatory reaction in the liver, usually secondary to inflammation of the gall-bladder or biliary tract. Since we have come to realize just how important the liver is as a detoxifying agent, it has occurred to us that this tissue reaction in the liver which we designate as hepatitis may be the remains of the detoxifying process. Hepatitis, which is recognized by enlargement of the liver, showing white lines on the surface composed of fibrous tissue, is an extremely common condition. The hepatic tissue is more firm than normal, the edge of the liver is either very sharp, coming to a white fibrous line, or else rounded or œdematous. In operations for abdominal lesions, examination of the liver will disclose this condition more often than a normal condition of the liver.

We have recently completed a study of twenty cases which, at the time of operation, were classified as cases of primary hepatitis. We were unable to find any lesion in the abdomen other than the hepatitis. In seven of these cases typical gall-bladder colic was present, and in about half of the num-

ber mild jaundice was associated. In eleven of the twenty cases there was upper abdominal pain, which, however, was not colicky in nature; therefore, about half of these patients had had attacks of colic characteristic of disease of the gall-bladder with stones. It seems possible that the colicky pain in cases of gall-stones may be due to some process in the liver at the time of the attack. In these twenty cases, the gall-bladder showed very slight, if any, change. There were no stones, but in view of the fact that the clinical symptoms were those of the usual bile-tract disease, the gall-bladder was removed. As a result of this procedure, nine (56 per cent.) of the patients stated that they were completely relieved of their symptoms. Six (37 per cent.) were improved but not entirely relieved. One patient was but little improved, if at all. Four could not be traced.

At the time these twenty patients were operated on, we thought that the hepatitis was a part of an infectious process which involved the gall-bladder and bile ducts, and that our only approach to this infection was by the removal of the gall-bladder. It is not possible to determine just what changes resulted from the removal of the gall-bladder in these cases. It is not likely that the hepatic tissue was greatly changed. Removal of the gall-bladder would eventually overthrow the action of the sphincter at the end of the common bile-duct so that by some physiologic changes the symptoms might have been relieved.

Analysis of these twenty cases seemed to show that the detoxifying effect of the liver may be manifested by the condition which is referred to as hepatitis. If this is true, removal of the gall-bladder might bring about a change by producing changes in the physiology of the liver.

Clinical Data.—At the present time the methods at our disposal do not measure, in any case of hepatic injury, all of the hepatic function. For the clinical evaluation of the disease before operation, we are limited to and dependent on data that concern only a few of the important phases of the metabolism of the liver, namely, those of excretion of bile and coagulation of blood.

The dye retention test, as proposed by Rowntree, Hurwitz and Bloomfield,[13] and as refined by Rosenthal,[12] is based on the fact that phenoltetrachlorphthalein is excreted only by the liver. The normal liver excretes all except 3 per cent. of this drug from the blood stream in fifteen minutes to an hour after intravenous injection. By measuring the amount of dye present in the blood at intervals after its administration it is possible to evaluate the degree of retention by the liver in cases of disease which may be either primary or secondary to obstruction to the extrahepatic ducts.

The van den Bergh reaction is an application of the diazo reaction for pigment. It is quantitatively accurate for the amount of pigment due to bilirubin in the blood serum and, as far as we know now, is qualitatively correct. Two types of reaction occur, the direct and the indirect. The first, occurring in obstructive and intrahepatic types of jaundice, is made by the direct addition of the reagent to the serum; the second, which occurs in

hemolytic jaundice, requires the addition of alcohol. The variation in reaction is probably based on whether the pigment molecule has passed through the polygonal cells of the liver.[10] Clinically, the type of reaction and the degree of serum pigmentation are most important in the diagnosis of disease of the liver and its appendages. In selecting the type of operation in jaundiced patients, the serum bilirubin curve should be considered. Experience teaches that the most favorable time for operation is when the pigment has reached a more or less constant level in the blood, and not while it is fluctuating. It is of interest that degrees of jaundice of the skin apparently do not parallel those of the blood serum. This is especially noticeable in the fluctuating types in which the serum level increases more rapidly than the pigmentation of the skin, and subsides more rapidly. This teaches that clinical methods of estimating jaundice are important and that they should without doubt influence the surgeon within limits in choosing the time for, and the type of, operation.

Methods of cholecystography may be considered in part as Röntgen-ray adaptations of the dye method of measuring hepatic function, and they are undoubtedly of assistance in surgical problems, especially those related to the gall-bladder and ducts.

Readings of coagulation time should be made frequently before surgical intervention in jaundiced patients, preferably at regular intervals throughout the day for several days, since it is known that there are hourly variations in this factor. It is interesting that a parallel does not exist between the daily fluctuation in coagulation time and the serum bilirubin levels in any case, showing that these hepatic functions are attacked by disease in different degrees at the same time. This emphasizes again the complex nature of hepatic disease and the confusion that results from the efforts of internists and surgeons satisfactorily to fix in mind any reliable estimate of the disease as it appears at the operating table or at post-mortem examination. One is impressed with the fact that these various means of establishing the degree of hepatic injury are not complete or infallible, and that they are hardly more than valuable adjuncts to the clinical data, the history, and the general examination as interpreted in the light of experience.

The treatment of surgical degrees of hepatic disease is limited to the known methods of combating jaundice and increasing coagulation time. The best methods include the administration of calcium chloride intravenously on three successive days,[16] the giving of blood transfusions and the intravenous infusion of glucose in 10 per cent. concentration. Gum acacia suspension has been tried as a pre-operative method of increasing blood viscosity but with little, if any, effect. The diet should be high in carbohydrate; the water intake should be from 3000 to 4000 cubic centimetres daily.

Decholin has been used in cases of serious injury to the liver to stimulate the flow of bile. Wakefield and Powelson[15] have shown, in clinical work, that decholin has a strong cholagogic action in that it will increase water excretion in bile by approximately twice the normal amount, although

the excretion of bile pigment and bile acids remains quantitatively the same. In a recent case of suppurative cholangitis without stones and with severe injury to the liver, following T-tube drainage, for five days bile did not flow. After the administration of one gram of decholin on two consecutive days the drainage of bile amounted to 920 cubic centimetres on the third day.

PATHOGENESIS.—Much progress has been made in the study of infection and undoubtedly certain of the conditions found in the hepatic system are the result of infectious processes. When one attempts to prove this, however, one meets with many surprises for it is frequently impossible to demonstrate bacteria of any kind in gall-bladders that are greatly changed as a result of disease. Some observers even go so far as to say that disease of the gall-bladder is never due to infection. Many different theories have been suggested, all of which are difficult to prove, but it must be admitted that benign non-infectious disease frequently exists in the gall-bladder. On more than one occasion in the clinic, bacteriologic studies have been carried out on a series of gall-bladders removed at operation. The results have varied greatly. It was possible to obtain growth of organisms in only 50 per cent. of the cases. In all cases the gall-bladder was removed because of disease. We were usually able to obtain a culture from the bile in about 7 per cent., and from stones, if they were present, in about 10 per cent.; the wall of the gall-bladder produced a growth of bacteria in as high as 49 per cent. It is likely that, as Wilkie suggested, bacteria are destroyed when they come in contact with the bile, so tissues for bacteriologic study should not be exposed to bile. Wilkie [19] has shown that cultures can be obtained much more often by culturing the tissue from the cystic gland at the neck of the gall-bladder than by culturing the wall of the gall-bladder. He believes this is due to the fact that the glandular tissue is not contaminated with bile.

We have fairly definite evidence to show that certain chemical changes in the blood may produce manifestations in the wall of the gall-bladder not unlike the condition spoken of as cholecystitis. It is possible that under certain conditions the chemical changes in the blood may be altered so as to result in this manifestation.

"Cholesterosis," presents an interesting study. If we think of cholesterosis as disease of the gall-bladder, it must be that this disease is due to changes in the metabolism. Occasionally there are stones in gall-bladders which show these changes, and sometimes there is associated inflammation in the wall; at other times the only change in the tissues is the deposit of lipoid seen in the epithelial wall. It has been suggested by Sweet [14] that this is an indication of the fact that the gall-bladder may play a part in the metabolism of fats.

The introduction of the method of studying the gall-bladder with the Röntgen-ray and dye test has added to the group of cholecystic changes one which must be termed functional cholecystic disease. This has enabled us to study the function of the gall-bladder and also permitted us to make a

diagnosis of disease based on disturbance of one or more of the functions. Undoubtedly these functions, concentration of the contents and equalization of the pressure, are most often altered when the gall-bladder is diseased. We should constantly bear in mind that this test is a functional test, and that a gall-bladder which is fairly normal histologically may be disturbed functionally. In our experience it has seemed that we were not justified in basing surgical procedures entirely on functional disturbance.

Besides the problem of infection, chemical changes in the blood, and metabolic and functional disturbances, there is another important one. There may be a definite clinical syndrome of disease of the gall-bladder and yet, at operation, disease cannot be recognized. In some of these cases the gall-bladder has been removed because of clinical symptoms and a number of the patients have obtained relief of symptoms. Because removal of the gall-bladder results in relief of symptoms does not prove, however, that the gall-bladder was diseased. The common duct is always dilated from loss of function of the gall-bladder, and, furthermore, the sphincteric action at the end of the duct is eventually overthrown. The real trouble in certain of those cases may be in the liver, in the form of hepatitis, or cholangitis, or the symptoms may be due to inflammation in the pancreas which might be affected by removal of the gall-bladder. Much is being said about the problems connected with the sympathetic nervous system and in this mechanism we may possibly have some such problem. There is a definite sphincteric action at the end of the common bile duct. Spasmodic action of this muscle might produce symptoms, and in view of the fact that cholecystectomy overcomes sphincter action, relief of symptoms might be obtained in this way.

We believe that cholangitis exists more often and to a more marked degree in association with cholecystitis than we formerly believed. If cholangitis can be recognized either with or without jaundice, then the common duct should be opened and drained. Drainage, as a rule, has not been maintained for a sufficient period. In fewer instances stones will recur if prolonged drainage is carried out. Prolonged drainage of the common duct undoubtedly enables the liver to recover its normal physiologic processes more readily. It is indicated in all cases in which there is recurrence of trouble, whether it is due to reformation of stones or to a residual or a recurrent condition in the liver, pancreas, or ducts.

The Effects of Continuous Drainage of Bile.—Undoubtedly continuous loss of all of the bile through a draining sinus cannot be withstood indefinitely. It is difficult, however, to obtain any accurate data concerning the effects on the human being of the loss of all of the bile. First, it is not possible to determine that all of the bile is coming to the outside because a biliary sinus exists. It has been readily shown in animals that a small amount of bile passing into the intestinal tract in a normal way changes the entire picture. There is no question, however, but that the continuous loss of bile eventually becomes very serious. In some of the cases in which

prolonged drainage has been carried out, marked general improvement is manifested as soon as bile is forced down into the duodenum. In others, tremendous quantities of bile continue to drain to the outside for a long time without any change resulting. Bile salts are undoubtedly very essential, and it is likely that the hepatic functions are stimulated better by bile salts than by anything else.

It has been shown experimentally that if all the bile is lost by drainage to the outside, the animal will die in a few weeks. It has been shown also that if these animals having complete biliary fistulas are fed on bile and liver, they will live almost a normal life.

SURGERY.—If these conceptions of the physiology and pathology of diseases of the gall-bladder and bile passages are correct, then there is very little occasion for the operation of cholecystostomy except as a temporary procedure. If operated on at all, the gall-bladder should be removed, for it is undoubtedly only a part of a disease condition throughout the biliary tract.

The functional activities of the liver are carried on by two distinct epithelial systems: one of these is made up of the hepatic cells which are particularly active in the function of storing glycogen. They undoubtedly also have much to do with the formation of urea and metabolism of bile salts, as well as other functions. In all probability inflammation or obstruction in the bile ducts interferes a good deal with the activity of these cells. Even if disturbed for a long time, they may recover and even regenerate in cases in which there is actual destruction of some of the tissues. Surgical procedure is indicated then to remove inflammatory and necrotic tissue and to release all pressure in the bile ducts. The other type of hepatic cell is the endothelial, which is called the stellate or Kupffer cell. This is a part of the general reticulo-endothelial system. Undoubtedly inflammation and obstruction of the biliary passages also interfere greatly with the activity of this cell. Relief of these conditions is indicated in biliary surgery in order to allow these cells to regain their function.

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CHRONIC CALCULOUS CHOLECYSTITIS

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In former years argument frequently arose as to whether cholecystectomy or cholecystostomy was the operation *par excellence* in the surgical treatment of gall-stones. Cholecystectomy, at least in the majority of minds, has triumphed, and cholecystostomy has been confined to the acute or rare chronic gall-bladder. With the advent of non-surgical biliary drainage, an impetus was given to the medical treatment of gall-bladder disease, occasionally a medical enthusiast stating that biliary surgery influences little the morbidity of the patient.

In an endeavor to throw some light on this subject, the "follow up" records of the Lankenau Hospital in all cases of biliary surgery during the years 1921 to 1925, inclusive, were carefully investigated.

This contribution deals only with chronic calculous cholecystitis, with or without an acute exacerbation. The results of acute cholecystitis and chronic non-calculous cholecystitis will be reported in the future.

The "follow-up" department of the Lankenau Hospital employs the following classifications: A. A. A. means the end result which is considered anatomically, symptomatically, and economically perfect. In other words, the condition of the wound, the relief of symptoms, and the working capacity of the patient. A. A. A. means a perfect result, and is the highest rating. D. D. D. is the lowest result with survival, and E. E. E. means ultimate death of the patient.

In the years 1921–1925 inclusive, there were 400 patients operated for chronic calculous cholecystitis. Thirty-eight of these died as the result of the operation. Of the remaining 362, the "follow-up" records were incomplete in nineteen instances. This leaves 343 patients whose condition is known from three months to five years after operation. These are divided for convenience into fifteen groups, represented by fifteen tables.

Table I deals with the cases of chronic calculous cholecystitis, in which a cholecystectomy was performed. One hundred seventy-four were heard from—148 had a perfect result, fifteen were improved, ten were no better nor worse than before operation. The percentage of improvement was 93.7. One patient died thirteen months after operation, the cause of death unknown, but she had been entirely relieved of gall-bladder symptoms when last heard from. There were three cases in which an acute suppurative appendicitis complicated the gall-bladder disease. The appendix was removed in all but forty-six instances.

TABLE I

Chronic Calculous Cholecystitis
Cholecystectomy

Number of cases	Time elapsed since operation	Condition		
		Anatomic	Symptomatic	Economic
2	To 3 months	A	A	A
16	3 to 6 months	A	A	A
1	3 to 6 months	A	B	A
1	3 to 6 months	A	C	D
1	3 to 6 months	B	C	B
9	6 to 9 months	A	A	A
2	6 to 9 months	A	B	A
1	6 to 9 months	A	D	A
1	6 to 9 months	D	D	D
9	9 to 12 months	A	A	A
1	9 to 12 months	A	B	A
1	9 to 12 months	A	C	A
18	12 to 15 months	A	A	A
3	12 to 15 months	A	B	A
1	12 to 15 months	A	B	B
1	12 to 15 months	E	E	E
17	15 to 18 months	A	A	A
1	15 to 18 months	A	D	A
1	15 to 18 months	B	B	B
3	18 to 21 months	A	A	A
1	18 to 21 months	A	B	A
5	21 to 24 months	A	A	A
1	21 to 24 months	A	B	A
1	21 to 24 months	A	B	B
42	24 to 27 months	A	A	A
3	24 to 27 months	A	B	A
11	27 to 30 months	A	A	A
2	27 to 30 months	A	B	A
2	30 to 33 months	A	A	A
1	30 to 33 months	B	A	A
3	33 to 36 months	A	A	A
9	36 to 39 months	A	A	A
1	36 to 39 months	A	B	A
1	47 months	A	A	A
1	54 months	A	A	A

Table II consists of chronic calculous cholecystitis in which a choledochostomy was performed in addition to cholecystectomy, or a cholecystostomy alone was done. Of the former operations there were five; of these four had a perfect result, one a very poor one. Of the latter operation there were

four; a perfect result was recorded in three and one was unimproved. The percentage of improvement was 77.7.

TABLE II

Cholecystectomy and Choledochostomy

Number of cases	Time elapsed since operation	Condition		
		Anatomic	Symptomatic	Economic
1	5 months	A	A	A
1	16 months	D	D	D
1	24 months	A	A	A
1	29 months	A	A	A
1	37 months	A	A	A

Cholecystostomy

Number of cases	Time elapsed since operation	Condition		
		Anatomic	Symptomatic	Economic
1	11 months	A	A	A
1	14 months	A	A	A
1	24 months	A	A	A
1	40 months	B	A	A

Table III is made up of the cases of chronic calculous cholecystitis with an acute exacerbation in which cholecystectomy was performed. There

TABLE III

Chronic Calculous Cholecystitis with Acute Exacerbation
Cholecystectomy

Number of cases	Time elapsed since operation	Condition		
		Anatomic	Symptomatic	Economic
1	To 3 months	A	A	A
10	3 to 6 months	A	A	A
2	3 to 6 months	A	B	A
1	6 to 9 months	A	A	A
1	6 to 9 months	B	A	A
8	9 to 12 months	A	A	A
1	9 to 12 months	C	A	A
5	12 to 15 months	A	A	A
6	15 to 18 months	A	A	A
1	15 to 18 months	A	B	A
3	18 to 21 months	A	A	A
9	21 to 24 months	A	A	A
1	21 to 24 months	A	B	B
5	24 to 27 months	A	A	A
1	24 to 27 months	A	B	A
1	27 to 30 months	A	A	A
2	33 to 36 months	A	A	A
1	33 to 36 months	E	E	E

were fifty-nine cases; fifty-one showing a perfect result, four improved, three unimproved, and one fatality. The percentage of improvement was

95. In nineteen cases the appendix was not removed, and in one case an acute suppurative appendicitis occurred as a complication. The one death occurred from subhepatic abscess six months after cholecystectomy and choledochostomy.

Table IV deals with chronic calculous cholecystitis complicated by chronic pancreatitis, for which several types of operation were performed. Twenty-five patients reported that they have since been in perfect health; two reported improvement, and one was in perfect health ten months after

TABLE IV

Chronic Calculous Cholecystitis Complicated by Chronic Pancreatitis

Cholecystectomy and Choledochostomy

Number of cases	Time elapsed since operation	Condition		
		Anatomic	Symptomatic	Economic
1	5 months	A	B	B
1	8 months	A	A	A
2	12 months	A	A	A
1	13 months	A	A	A
1	18 months	A	A	A
1	19 months	A	B	A
2	24 months	A	A	A
1	32 months	A	A	A
1	37 months	A	A	A
1	44 months	A	A	A
1	48 months	A	A	A

Cholecystectomy Only

Number of cases	Time elapsed since operation	Condition		
		Anatomic	Symptomatic	Economic
4	5 months	A	A	A
1	10 months	A	B	A
2	12 months	A	A	A
1	16 months	A	A	A
2	24 months	A	A	A
1	26 months	E	E	E
1	38 months	C	B	C
1	60 months	A	A	A

Cholecystoduodenostomy

Number of cases	Time elapsed since operation	Condition		
		Anatomic	Symptomatic	Economic
1	12 months	A	A	A
1	16 months	A	A	A
1	20 months	A	A	A

TABLE IV—(*Continued*)

Cholecystostomy

Number of cases	Time elapsed since operation	Condition		
		Anatomic	Symptomatic	Economic
1	23 months	A	A	A

operation but died in twenty-six months, from angina pectoris. In one case there was a questionable malignancy of the pancreas, at five months reported A. B. B. The percentage of improvement was 90.

Table V represents chronic calculous cholecystitis complicated by stone in the common duct. Cholecystectomy and choledochostomy were done in all but one instance, where a cholecystectomy was sufficient to remove all stones; twenty-six were in perfect health and one was improved, the percentage of definite improvement being 96.4.

TABLE V

Chronic Calculous Cholecystitis Complicated by Stone in Common Duct
Cholecystectomy and Choledochostomy

Number of cases	Time elapsed since operation	Condition		
		Anatomic	Symptomatic	Economic
1	2 months	A	A	A
1	4 months	A	B	A
4	5 months	A	A	A
1	7 months	A	A	B
1	10 months	A	A	A
1	11 months	A	A	A
1	12 months	A	A	A
1	13 months	A	A	A
3	14 months	A	A	A
3	16 months	A	A	A
1	21 months	A	A	A
2	24 months	A	A	A
1	25 months	A	A	A
2	26 months	A	A	A
3	30 months	A	A	A
1	48 months	A	A	A

Cholecystectomy Only

Number of cases	Time elapsed since operation	Condition		
		Anatomic	Symptomatic	Economic
1	24 months	A	A	A

Table VI consists of several cases of chronic calculous cholecystitis with different complications; thirteen reported in perfect health, one was unimproved. The percentage of improvement was 92.8.

TABLE VI

Chronic Calculous Cholecystitis with Complications

Complication	Number of cases	Time elapsed since operation	Condition		
			Anatomic	Symptomatic	Economic
Chronic pancreatitis and stone in common duct.—					
Cholecystectomy and choledochostomy	1	13 months	A	A	A
	1	49 months	A	A	A
Hydatid cyst of liver	1	25 months	A	A	A
Subacute pancreatitis.—					
Cholecystostomy	1	35 months	A	A	A
Cholecystectomy	1	4 months	A	A	A
Cirrhosis of liver.—Cholecystectomy	1	17 months	A	A	A
Cholecystoduodenostomy	1	5 months	B	B	A
	1	17 months	A	A	A
	1	18 months	A	A	A
Pancreatic lymphangitis.—					
Cholecystectomy	1	16 months	A	A	A
Cholecystectomy and choledochostomy	1	24 months	A	A	A
	1	25 months	A	A	A
	1	32 months	A	A	A
	1	36 months	A	A	A

Table VII consists of the cases of chronic calculous cholecystitis in which a previous cholecystostomy had been performed, and which were later subjected to cholecystectomy. Results: eight showed a perfect result, one was improved, and two were unimproved or worse than before the cholecystectomy. The percentage of improvement was 81.8.

TABLE VII

Cases Having Had Previous Cholecystostomy

Number of cases	Time between operations	Time since last operation	Condition		
			Anatomic	Symptomatic	Economic
1	3 months	10 months	A	A	A
1	12 months	25 months	A	B	A
1	12 months	49 months	A	A	A
1	17 months	24 months	A	A	A
1	6 years	24 months	A	A	A
1	7 years	13 months	A	A	A
1	8 years	13 months	A	A	A
1	8 years	24 months	A	A	A
1	12 years	14 months	C	C	A
1	12 years	25 months	A	A	A
1	14 years	10 months	A	A	C

Table VIII includes those cases of gall-stone disease in which a definite lesion was found in the gastro-intestinal tract, exclusive of appendicitis—

seven in all. Five stated that they were perfectly well, one was improved, and one was unimproved.

TABLE VIII

Chronic Calculous Cholecystitis with Complications of Gastro-intestinal Origin

Complication	Operations performed	Number of cases	Time elapsed since operation	Condition		
				Anatomic	Symptomatic	Economic
Duodenal ulcer:	Pylorectomy, posterior gastro-enterostomy, cholecystectomy	1	24 months	A	A	A
	Excision ulcer, posterior gastro-enterostomy, cholecystectomy	1	26 months	A	A	A
	Excision ulcer, cholecystectomy	1	4 months	A	B	B
	No operation for ulcer	1	4 months	A	B	A
Diverticulum of of duodenum:	Invagination of diverticulum, choledochostomy, cholecystectomy	1	24 months	A	A	A
Carcinoma of appendix:	Appendectomy and cholecystectomy	1	26 months	A	A	A
Mesenteric thrombosis:	Thrombectomy and cholecystectomy	1	6 months	A	A	A

Table IX shows the cases in which a secondary operation was performed—eleven in number. In one case there was no reply from the patient; five gave a perfect result, one was improved, and the other five were ultimately worse than before the operation.

Table X consists of five cases whose histories are given in detail below, because of the severity of their illness and their many complications (but are not included in the above list.) One had perfect result, one died, and the other three were worse than before operation.

TABLE X

	Condition		
	Anatomic	Symptomatic	Economic
In detail—I	E	E	E
In detail—II	D	D	D
In detail—III	D	D	D
In detail—IV	D	D	D
In detail—V	A	A	A

Table XI shows the proportion of males to females. There were seventy-four males; fifty-eight giving a perfect result, a percentage of 78.3; eight others were improved, 10.8 per cent., making a total percentage improvement

TABLE IX
Cases Readmitted to Hospital

Primary pathology	Primary operation	Time between operations or treatments	Medical treatment	Secondary operation	Condition		
					Anatomic	Symptomatic	Economic
Cholelithiasis and abdominal adhesions—visceroptosis	Cholecystectomy—release of adhesions	4 months	Abdominal support for visceroptosis		A	A	A
Cholelithiasis and stone in common duct	Cholecystectomy, choledochostomy	7 months		Appendectomy	A	A	A
Cholelithiasis and chronic appendicitis	Cholecystectomy, appendectomy	13 months		Release of abdominal adhesions	A	A	A
Cholelithiasis and chronic appendicitis — visceroptosis	Cholecystectomy, appendectomy	2 months	Medical treatment —abdominal support for ptosis		A	A	A
Cholelithiasis and chronic appendicitis	Cholecystectomy, appendectomy	1 month		Release of adhesions —choledochostomy	A	A	A
Cholelithiasis—pus in common duct—chronic appendicitis	Cholecystectomy, Choledochostomy, appendectomy	6 months		Release of adhesions for intestinal obstruction	A	B	A
Cholelithiasis	Cholecystectomy	6 months (readmitted 4 months later)		Intestinal obstruction — incarcerated incisional hernia	C	B	A
Cholelithiasis—chronic pancreatitis—chronic appendicitis	Cholecystectomy, appendectomy	2 months		Abscess subhepatic incision and drainage	C	B	B
Cholelithiasis and abdominal adhesions	Cholecystectomy	3 months	Medical treatment for indefinite abdominal pain		C	C	C
Cholelithiasis — papilloma urethra	Cholecystectomy—excision papilloma	4 months		Carcinoma of liver	D	D	C
Cholelithiasis with acute exacerbation	Cholecystectomy	1 month		Cholecystoduodenostomy and posterior gastro-enterostomy	D	D	D

of 89.2. No deaths occurred among the males. There were 269 females, 230 giving a perfect result, or 85.5 per cent.; seventeen were improved, or 6.3 per cent., making a total improvement of 91.8 per cent. There were nineteen cases in which there were no replies from the patients.

TABLE XI

Sex of patient	Number of cases	Condition		
		Anatomic	Symptomatic	Economic
Male	58	A	A	A
	8	A	B	A
	2	A	B	B
	1	A	D	A
	1	B	A	A
	1	C	A	A
	1	C	B	A
	1	C	C	A
	1	C	C	C
Female	230	A	A	A
	17	A	B	A
	1	A	A	B
	3	A	B	B
	1	A	A	C
	1	A	C	A
	1	A	C	D
	1	A	D	A
	2	B	A	A
	1	B	B	A
	1	B	B	B
	1	B	C	B
	1	C	B	B
	1	C	B	C
	1	D	D	C
	3	D	D	D
	3	E	E	E

Table XII illustrates the duration of symptoms before operation in correlation with the "follow-up" record. The cases whose symptoms were less than six months totalled seventy-two, and sixty-four of them stated they were perfectly well. Patients having symptoms from six to twenty-four months numbered seventy-six, and sixty-two were perfectly well. From two to six years there were 126, with 107 having the best result. Those whose symptoms covered from six to thirty-five years numbered sixty-nine, with fifty-five perfectly well. It is interesting to note that the three patients whose symptoms had lasted twenty-five, thirty, and thirty-five years, respectively, all gave a perfect result.

Table XIII correlates the ages of the patients and the results. From ten to twenty years of age there were three; one being entirely relieved. From twenty to forty years there were 147; 122 reporting perfectly well. From forty to sixty years there were 166; 143 perfectly well. From sixty years onward there were twenty-seven; twenty-two of whom had perfect results.

TABLE XII
Duration of Symptoms

Length of time	Number of cases	Condition		
		Anatomic	Symptomatic	Economic
1 to 30 days	22	A	A	A
	2	A	B	A
	1	B	A	A
	1	D	D	D
1 to 3 months	20	A	A	A
	1	A	B	A
	1	A	B	B
	1	A	C	D
3 to 6 months	22	A	A	A
	1	A	B	B
6 to 9 months	18	A	A	A
	1	A	B	A
	1	A	A	B
	1	B	B	B
	1	C	B	C
9 to 12 months	10	A	A	A
	1	A	B	A
	1	B	A	A
12 to 18 months	21	A	A	A
	3	A	B	A
	1	B	B	A
	1	C	A	A
	1	C	B	A
	1	D	D	D
18 to 24 months	13	A	A	A
	1	A	B	A
24 to 30 months	25	A	A	A
	3	A	B	A
	1	A	B	B
	1	A	D	A
30 to 36 months	24	A	A	A
	1	A	B	A
	1	A	B	B
	1	A	D	A
	1	E	E	E
3 to 6 years	58	A	A	A
	6	A	B	A
	1	B	C	B
	1	C	B	B
	1	D	D	C
	1	D	D	D
6 to 9 years	13	A	A	A
	3	A	B	A
	1	A	B	B
	1	A	C	A
	1	B	A	A
	1	C	C	C
	1	E	E	E
9 to 12 years	25	A	A	A
	1	C	C	A
12 to 15 years	7	A	A	A
	2	A	B	A
	1	A	A	C
	1	E	E	E
15 to 20 years	7	A	A	A
	1	A	B	A
20 to 25 years	1	A	A	A
25 to 30 years	1	A	A	A
30 to 35 years	1	A	A	A

TABLE XIII

Age of patient	Number of cases	Condition		
		Anatomic	Symptomatic	Economic
10 to 15 years	1	A	A	A
15 to 20 years	1	A	B	A
	1	A	D	A
20 to 25 years	12	A	A	A
	3	A	B	A
	1	B	A	A
	1	D	D	D
25 to 30 years	28	A	A	A
	3	A	B	A
	1	A	D	A
	1	B	A	A
	1	C	A	A
30 to 35 years	37	A	A	A
	3	A	B	A
	1	B	A	A
	1	D	D	C
	1	E	E	E
35 to 40 years	45	A	A	A
	3	A	B	A
	1	A	B	B
	1	A	C	D
	1	B	B	A
	1	B	C	B
	1	C	B	B
40 to 45 years	40	A	A	A
	1	A	B	A
	1	C	C	C
	1	D	D	D
	1	E	E	E
45 to 50 years	35	A	A	A
	5	A	B	A
	2	A	B	B
	1	B	B	B
	1	E	E	E
50 to 55 years	43	A	A	A
	4	A	B	A
	1	A	A	B
	1	A	A	C
	1	A	B	B
	1	A	C	A
	1	C	B	C
	1	D	D	D
55 to 60 years	25	A	A	A
60 to 65 years	18	A	A	A
	1	A	B	A
	1	C	B	A
	1	C	C	A
65 to 70 years	2	A	A	A
	1	A	B	A
	1	A	B	B
70 to 75 years	1	A	A	A
Age not given	1	A	A	A

Table XIV shows the number and type of operations performed for lesions in addition to the bile duct surgery.

TABLE XIV

Operations Performed for Pathology Outside of Biliary Tract
(In addition to gall-bladder surgery)

Operation	Number of cases	Time elapsed since operation	Condition		
			Anatomic	Symptomatic	Economic
Perineorrhaphy D and C	1	12 months	A	B	A
Hæmorrhoidectomy	1	24 months	A	A	A
Excision polyp	1	25 months	A	A	A
Incisional hernia	1	24 months	A	A	A
Hysteropexy	1	25 months	A	A	A
	1	23 months	A	B	A
Trachelorrhaphy	1	17 months	A	A	A
D and C application of radium	1	24 months	A	A	A
Repair of ventral hernia	1	5 months	A	A	A
Subdiaphragmatic abscess—incision and drainage	1	26 months	A	A	A
Repair right inguinal hernia	1	4 months	A	B	A
Hysterectomy for myoma	1	11 months	A	A	A

Table XV illustrates the post-operative complications and some of their results.

TABLE XV

Post-operative Complications

Complication	Number of cases	Time elapsed since operation	Condition		
			Anatomic	Symptomatic	Economic
Bilateral parotitis	1	36 months	A	A	A
Acute pancreatitis—incision and drainage	1	48 months	A	A	A
Pneumonia	1	2 months	A	A	A
	1	5 months	A	A	A
	1	12 months	A	A	A
	1	25 months	A	A	A
	1	34 months	A	A	A
	1	6 months	A	B	A
	1	8 months	C	B	B
Biliary fistula	1	14 months	A	A	A
Hernia wound	1	4 months	A	B	A
Cardiac attack	1	24 months	A	A	A
Secondary hæmorrhage	1	16 months	A	A	A
Bronchitis	3	Not of sufficient severity to affect results			
Stitch abscess	1	Not of sufficient severity to affect results			
Urinary retention	1	Not of sufficient severity to affect results			
Urinary suppression	1	Not of sufficient severity to affect results			
Phlebitis	2	Not of sufficient severity to affect results			
Cystitis	2	Not of sufficient severity to affect results			
Slight infection of wound	10	Not of sufficient severity to affect results			
Severe infection of wound	1	Not of sufficient severity to affect results			

CASE REPORTS

CASE I.—Female, forty-three years of age, had suffered from upper abdominal attacks of pain during a period of six years. A cholecystectomy was performed for hydrops of the gall-bladder with stone, May 6, 1924. Following operation a biliary fistula developed. Patient was readmitted to the hospital September 26, 1924, at which time the fistula was excised and a choledochoduodenostomy done. This operation was complicated by a hernia of the omentum. Following the last operation she continued to have symptoms, with jaundice, and was again readmitted, December 6, 1924. She remained a week under medical treatment and then returned home, where she died in January, 1925. E. E. E.

CASE II.—Female, twenty-three years of age, had suffered from gall-bladder symptoms for about four weeks. She was admitted to the hospital March 6, 1924, at which time a cholecystectomy and appendectomy were done. Following this the patient continued to have symptoms of substernal distress, fever, deep jaundice, and a biliary fistula. A hepaticoduodenostomy was performed and the patient progressed nicely (although having an occasional pain in the epigastrium), until ten months after operation. Then she developed chills, fever, and jaundice, with attacks of intense pain in the epigastrium. On October 14, 1926, she was in a worse condition than before the operation. D. D. D.

CASE III.—Female, forty-three years of age, suffering from recurrent attacks of upper abdominal pain during a period of six years was admitted to the hospital June 3, 1923. A cholecystectomy was done. Following the operation a biliary fistula developed. She was readmitted July 2, 1923, when the fistula was repaired, a choledochoduodenostomy and a posterior gastro-enterostomy for pyloric obstruction were performed. Ten months following this she still had attacks of pain, chills, fever, and jaundice, and her condition showed no improvement. D. D. D.

CASE IV.—Female, thirty-eight years of age, was admitted to the hospital March 9, 1924, with the history of having had an operation for perforation of the gall-bladder in 1921, at which time the gall-bladder was removed piecemeal. At operation March 14, 1924, a portion of the gall-bladder was removed and an old biliary fistula excised. About twenty-four months later she began to have attacks of severe pain in the upper right abdomen, with chills, fever, and jaundice. She was readmitted April 13, 1926, when a choledochostomy was performed for chronic pancreatitis; nine months later she was still unimproved. D. D. D.

CASE V.—Female, fifty-one years of age, was admitted to the hospital November 3, 1924, with the history of attacks of pain in the right upper abdomen for five months, and a previous pyelotomy for stone in the right kidney. On November 6, 1924, a cholecystostomy for removal of gall-stones and an appendectomy and a right nephrectomy were performed. She was readmitted December 22, 1924, when a cholecystectomy and choledochostomy were done for stones and chronic pancreatitis; twenty months later she was much improved. On November 21, 1927, she was again readmitted and a second choledochostomy done for subacute pancreatitis. One month after last dismissal she was feeling very well. A. A. A.

DISCUSSION

While the total operative mortality was quite high in comparison with some other clinics, this was contributed to by the severity of many of the cases and the necessity for extensive surgical procedures. Only three remote deaths occurred in the 343 cases whose records are known: one from an unknown cause eleven months after operation, a second from angina pectoris

twenty-six months after operation, and the third from a subhepatic abscess six months after operation. Of the above 343 patients, 288 stated that they were perfectly well, or a percentage of 83.9 recoveries; 27 additional patients were improved, or a percentage improvement of 91.8.

The performance of choledochostomy, cholecystostomy, and cholecystoduodenostomy when indicated, although adding more risk to the immediate mortality, would seem to be justified by the excellent results obtained in the cases in which they were done. Gastric surgery or the fact that the patient had submitted to a previous cholecystostomy did not seem to influence the excellent results. Females had a better mortality record than the males. Duration of symptoms influenced the results less than is commonly thought. Those having symptoms for less than six months gave a perfect result of 88.8 per cent. Symptoms lasting from six months to two years showed a complete recovery for 81.5 per cent. From two to six years, 84.9 per cent. had a perfect result, while 79.7 per cent. of those with symptoms over six years had a perfect result. Age seems not to have influenced the result except in the cases of patients under twenty years, in which group only 33.3 per cent. gave a perfect result. From twenty to forty years, 83 per cent. were well. From forty to sixty years, 86.1 per cent. were well. From sixty years onward, 81.5 per cent. were well.

In the final result we must include the additional five cases considered in detail. Therefore, of 348 cases, 289 had a perfect result, or a percentage cure of 83 per cent.

From this review we feel that surgery in chronic calculous cholecystitis is of very definite value, and offers an assurance of relief of symptoms in a far greater proportion of cases than any other form of treatment.

ACCIDENTAL OR COMPENSABLE HERNIA*

REPORT OF THE COMMITTEE OF THE AMERICAN RAILWAY ASSOCIATION

By Clarence W. Hopkins, M.D., of Chicago; Southgate Leigh, M.D., of Norfolk; John B. Walker, M.D., of New York; Jonathan M. Wainwright, M.D., of Scranton, and William B. Coley, M.D., of New York; Chairman

At a meeting of the Medical and Surgical Section of the Committee of Direction of the American Railway Association held in Washington on February 13, 1929.

A request for a definition of accidental rupture, was received from T. H. Carrow, Superintendent of Safety, Pennsylvania Railroad, dated May 25, 1927, with the recommendation that the following definition be adopted:—

"*Definition of Accidental Hernia:* Hernia should be considered accidental where there is real traumatic hernia resulting from the application of force directly to the abdominal wall, either puncturing or tearing the wall.

"All other cases should be considered as either congenital or of slow development, being a disease rather than an accidental injury, unless conclusive proof is offered that the hernia was immediately caused by such sudden effort or strain that:

1. The descent of the hernia immediately followed the accident.
2. That there was severe pain in the hernial region.
3. That there was such prostration that the employee was compelled to cease work immediately.
4. That the above facts were of such severity that the same was noticed by the employee and communicated to the employer within twenty-four hours after the occurrence of the hernia.
5. That there was such physical distress that the attendance of a licensed physician was required within twenty-four hours after the occurrence of the hernia."

In 1921 a Committee was appointed by the American Railway Association to make a careful study of the subject of Traumatic and Industrial Hernia. In 1922 the Committee made this report and it was published in the Annals of Surgery and in the Proceedings of the American Railway Association.

The findings of this Committee have been very widely adopted as representing the most recent opinion of representative American surgeons. The more important question is, has it been accepted by the Courts and by Industrial Commissions? A careful study of the more important decisions made by the different State Commissions, especially in the "Hearing De Novo on the Subject of Hernia" held on October 11, 1923, at Philadelphia (in

* Presented at the annual meeting of the American Railway Association, May 8, 1929.

which four cases of the Glen Alden Coal Company were submitted to a Board of Commissioners), will show that the conclusions of our Committee on Traumatic Hernia have not been accepted without important qualifications. The following were the recommendations of our Committee in 1922:

1. Render proper compensation for all cases of true traumatic hernia due to direct violence. Such cases are so few in number as to be practically negligible.

2. Make a physical examination of all applicants for positions in industry no matter in what capacity; such examinations will determine the fact whether or not a hernia was present at the time of examination.

3. Any case of hernia developing in the course of duty, incident to the man's daily work, should be treated as a disease due to special anatomical weakness on the part of the individual, for which the Company is in no way responsible. If it is considered wise under certain circumstances to recognize any moral responsibility, let it be on an economic or humane basis. This moral obligation should be understood to be strictly limited to such employes who had been found apparently free from hernia at the time of previous physical examination.

In the Glen Alden Coal Company cases, Mr. Dever, the attorney for the plaintiff, bases his arguments on the following:

> In the decision of the Clark vs. the Lehigh Valley Coal Company, the Supreme Court declared as law that no standard of fitness was required of an employe when he enters the employment to entitle him to compensation for injuries suffered while at work. In the Clark case, a workman had an ulcer in the aorta, and by a vomit at work, broke the ulcer at a time sooner than it would have broken by the natural progress of the disease, and the Supreme Court held that that was an accident and would support a compensation claim under our Act.
>
> In the Clark case above referred to, the Supreme Court set at rest both propositions advanced by the employer in this lawsuit, in its effort to defeat a compensation claim for the hernias here in question. The first proposition is that no matter how weak the body is at a particular part, if something happened at work causing the final break, it is compensable, and the second proposition is that with a weak part within the body due to any cause, compensation is to be paid not only for the damage done by the last effort, but for the damage done by all efforts, if the last strain at work caused the final break.

At the Glen Alden hearing, each of their experts, when testifying, agreed that "there was a strain at work and they all gave evidence that each push, each effort, each exertion, plays its part in the development of the whole, and yet they would have you believe, in these specific cases, that the last effort made no difference. They cannot convince intelligent men that the last strain at work did not play a part in the development of these hernias, when they admit that each strain does not play a part in the final product."

The following quotation from the Counsel for the Defendant's Brief gives the other side of the picture:

> "There is no doubt that Doctor Biddle agrees with Doctor Wainwright, Doctor Coley, and the other doctors who testified on behalf of the defendant, not only in their

views as to the origin and cause of hernia, but that a true hernia as distinguished from a potential hernia was present and existing prior to the alleged accident in all three of these cases.

"The question in these cases, therefore, may fairly be stated to be whether the accident caused an aggravation of a preëxisting hernia: if this is answered in the negative no further inquiry need be made, if in the affirmative, then comes the further question as to the effect of the aggravation on the man's ability to work.

"While there has been no suggestion of fraud in any of the three cases here presented, errors having the same effect creep into every hernia case. The man suffering from a hernia, or from any other condition which he does not fully understand, almost invariably and immediately looks for some external cause. Incidents which would ordinarily be passed unnoticed, or be soon forgotten, when followed by pain or other untoward circumstances, are immediately thought of as being the cause thereof. The average man suffering from a hernia cannot be convinced that the cause was not the trivial accident which the doctors all agree merely brought it to his attention, and in this connection is a most sincere and impressive witness.

"So after eliminating all improper factors, we consider the questions:

"A. Did the alleged accidents aggravate a preëxisting condition of hernia? and

"B. If so, did the aggravation cause disability beyond the ten-day period?

"The position of the claimants, therefore, may be summariezd thus: The employe is suffering from an existing condition which should be operated upon to effect a cure. The accident caused a change in this condition which is so slight and infinitesimal that it cannot be distinguished except by reasoning from effect to alleged cause—innumerable strains are the cause of the condition; therefore, each strain has played its part—and then, while the alleged changed condition does not interfere with the man's ability to do this work, merely because the employe may choose this particular time for an operation, claimants ask the employer not only to pay for the cure, but also to pay compensation for the time which is lost in convalescence.

"If claimants choose to continue to work, which they may do as the doctors all agree, the next day or the next week another similar incident will likely occur; of this the evidence leaves no doubt. This offers another opportunity to file a claim petition, and affords a basis for a demand for a cure and for compensation; or, why not go back and allow the employe to choose from any number of employers for whom he may have worked during the statutory period of one year, and make this choice as to who shall be liable for the expense of the operation, and the compensation payments during the period of his disability following the operation.

"The evidence clearly shows that the hernias suffered by claimants were of slow development. They came on gradually from continued strains and intra-abdominal pressure at work and away from work since the birth of claimants, and therefore not compensable because they are natural occupational in character."

In two out of the four cases the decision rendered was in favor of the employer and two in favor of the employe.

Following the decision in these cases, Chairman Walnut made a lengthy memorandum on the whole subject, entitled, "Hernia As a Compensable Accident under Workmen's Compensation Act of Pennsylvania" from which we quote the following:

Under the title of "Accidental or Sudden Hernia," he quoted Doctor Mock who states,

"The great majority of hernias develop slowly—the gradual dilatation by mesentery of a preformed sac. The congenital defect or predisposition is the chief cause for such hernias, and the relation of natural occupation or of the natural acts of ordinary life

is immaterial in their formation. These correspond to the gradual development of 'flatfoot,' as a result of faulty shoes, constant standing and walking or other natural causes; or to the development of tuberculosis in employes engaged in occupations which in no wise predispose to this condition.

"A small percentage of these hernias, however, make their first appearance after some unnatural occupational hazard which is out of all proportion to those ordinary or natural conditions. These correspond to the occupational diseases which are now recognized in some states as accidental and, therefore, compensable. These are border-line cases, for which no hard and fast rules can be laid down. The individual merits of each case must be carefully considered to arrive at an equitable settlement.

"Those surgeons who claim that only the true traumatic hernia is compensable do a great injustice to many employes. Those industrial commissions, which claim that all hernias developing as a result of 'strain' are compensable, do a great injustice to the employers. Both views are responsible for many of the fraudulent claims made for compensation by dishonest employes.

"Traumatic hernia is a misnomer as it indicates the very small group of hernias resulting from direct violence. Other types of hernia develop for which the occupation is more or less responsible and are described by Lothiessem and other German writers as 'accidental hernia.'

"I wish to advocate, therefore, that the term 'compensable hernia' be adopted in this country by both the medical and legal professions; and further, that this term shall include all cases of true 'traumatic hernia' and all cases of 'accidental hernia' in which the force causing their development is directly the result of some unnatural occupational hazard."

The rules adopted by the Nevada State Commission (quoted herewith) agree with the position taken by Doctor Mock:

"Rule 1. Real traumatic hernia is an injury to the abdominal wall (belly wall) of sufficient severity to puncture or tear asunder said wall and permit the exposure or protrusion of the abdominal viscera or some part thereof. Such injury will be compensated as temporary total disability, and as partial permanent disability, depending upon the injured individual's earning capacity.

"Rule 2. All other hernias, whenever occurring or discovered and whatsoever the cause, except as under Rule 1, are considered to be diseases, causing incapacitating conditions of permanent partial disability, and the causes of such are considered, as shown by medical facts, to have either existed from birth, to have been years in formation, or both, and are not compensatory, except as provided under Rule 3.

"Rule 3. All cases coming under Rule 2 in which it can be conclusively proved (first, that the immediate cause which calls attention to the presence of the hernia, was sudden effort or a severe strain or blow, received while in the course of employment; second, that the descent of the hernia occurred immediately following the cause; third, that the cause was accompanied or immediately followed by severe pain in the hernial region; fourth, that the above mentioned facts were of such severity that they were noticed by the claimant and communicated immediately to one or more persons) are considered to be aggravations of previous ailments or diseases, and will be compensated as such for time or loss only, depending on the nature of the proof submitted and the result of the local medical examination."

Our Committee of the American Railway Association in discussing the Rules of the Nevada Commission agreed unqualifiedly with Rules 1 and 2 but with regard to Rule 3 made the following statement:

"Hernia is practically always due, first, to the presence of a preformed sac or open pouch of peritoneum which, in the inguinal variety, follows the

testis in its descent into the scrotum, which pouch has failed to close in the normal way and second, to the presence of structural weakness in the neighborhood of the hernial orifices due to poorly developed muscles or fascia. Given these all-important anatomical causes which are in themselves sufficient in many cases to constitute a potential hernia, the actual hernia may develop by reason of a great variety of exciting causes; among these may be mentioned, the daily increase in intra-abdominal pressure incident to the ordinary routine of life, *e.g.,* straining at stool, coughing, sneezing, lifting, etc. The main point that cannot be emphasized too strongly is that the hernia is never the result of a single strain or single increase in intra-abdominal pressure due to any of the causes mentioned; on the other hand, it is the cumulative effort of a great number of strains spread over a considerable period of time. In nearly all cases hernia is a gradual onset, and is rarely accompanied by pain, and most frequently remains unnoticed until it reaches a considerable size or until some accident or strain by slightly increasing the contents of the hernial sac, causes it to be noticed for the first time. Hence, the accident or strain is usually the occasion which first attracts the attention to a hernia long present but hitherto undiscovered."

The decision of the Pennsylvania Commissioners in the hearing of the four cases *loc. cite* leans toward the position taken by Doctor Mock and the Nevada Commission.

As a matter of fact, out of the four cases decided, two of the four were in favor of the employer and two were in favor of the employe. So it is evident that the problem has not yet been definitely settled.

In the elaborate memorandum of this hearing formulated by Chairman Walnut—Subject: Hernia as a Compensable Accident under the Workmen's Compensation Act of Pennsylvania—the position taken by our Committee is quoted at length and discussed in a most fair and judicial manner. In addition, the opposing views are likewise presented. In his conclusions, Chairman Walnut states:

"A. Legal Definition of Accident.—The Pennsylvania Statute provides for the payment of compensation for personal injury to, or for the death of, 'an employe' by an accident in the course of his employment. The terms 'injury' and 'personal injury' as used in this Act shall be construed to mean only violence to the physical structure of the body and such disease or infection as naturally result therefrom."

The word "accident" has been so frequently interpreted that it is unnecessary to review the decisions. Briefly, however, it should be pointed out that in order to constitute a compensable injury under our statute, it is not necessary that it be caused by the unforeseen and unexpected application of external force. It may include a strain to which the employe has voluntarily subjected his body in the course of his employment and which has proved to be greater than his body could bear, as a result of which the injury occurred. It is unnecessary that the strain, to which the employe's body is so subjected, be an unusual strain. It is the unusual and unexpected

injury resulting from a particular strain that constitutes the accident. (See Smith *vs.* Pittsburgh Coal Company, 71 Superior, 325, 1919, 11 Mackey, 71; Tracy *vs.* Philadelphia & Reading Coal and Iron Company, 270 Pa., 75; Watkins *vs.* Pittsburgh Coal Company, 278 Pa., 463; Samoskie *vs.* Philadelphia & Reading Coal and Iron Company, 280 Pa., 203.)

In the first of the cases cited the question before the Court arose in connection with a hernia designated as umbilical. In the course of the discussion, it was contended that the employe's condition was not due to an accident, but to the development of an existing hernia, the existence of the hernia, prior to the alleged accident, being admitted by the claimant. The referee, however, found that this condition had never caused the employe any pain, inconvenience, or disability prior to the accident. This finding was affirmed by the Board together with his conclusion that the result of the accident, consisting of a change in the condition of the hernia, resulting in disability, constituted a compensable injury. It was, therefore, a clear case of the acceleration of the growth or development of a hernia due to a strain as the exciting cause.

The contention of the defendant "that the preëxisting condition of the claimant's body was the cause of the injury and not his effort to lift the car" was not viewed with favor by the Lower Court, which stated:

> "It would be unprofitable to undertake to lay down any rule by which events which precede other events may be determined to be or not to be causes of them. We have to deal with a matter which is not metaphysical, but practical. The real question is, of what nature and extent, a bodily defect or a bodily condition different from that of the average man must be, to require us to determine that an accident which would not have harmed a normal person, was not the cause of the injury, or what is more to the purpose in the present case, is not compensable under the Act. (Shafer P. J.) 1 Mackey, 88."

This analysis of the question was approved by the Superior Court.

"B. Application of Medical Principles.—It is with this understanding of our law that we have considered the medical discussions both in the testimony and in the writings of the several physicians. It is clear to us that our law, as interpreted, requires us in cases such as these to determine, not so much the cause of the hernia as the condition of disability. Not so much the predisposition as the degree in which the exciting cause contributed to the condition of disability. The effect of the violence or strain must be appreciable, not only in a scientific sense, but in the ordinary sense in which we use the phrase 'contributory cause.'"

As we have already suggested the recommendations of the Coley Committee were in line with the testimony of the defendant's physicians. These recommendations would entirely exclude hernias begun or accelerated in development either by extraordinary or ordinary efforts or strains, to which an employe may be subjected in the course of his work. The so-called hernias of effort.

In view of what we have already stated as to the scope of our statute we would have no authority to follow such recommendations.

We are satisfied from a consideration of the various medical statements on the subject that the physicians themselves relate a hernial condition in a reasonable number of cases to the cause to which it is ascribed by the patient. Doctor Coley, himself, certainly in his earlier utterances, at least, recognized this relationship. In his address in 1903, he suggests that a casual connection must be recognized "since a preëxisting hernia has been made worse by the accident or injury."

The Committee of the American Railway Association believes that according to the Law of the State of Pennsylvania many of the cases of hernia might be helpful both to employer and employes. In our former report we used the term traumatic and industrial hernia for three groups.

1. Using the term traumatic to include only the very small group of cases in which the hernia was caused by direct local violence.

2. Under the heading Occupational Hernia and Industrial Hernia or better the French term "Hernia d' Effort," to include all the cases which appear suddenly or at least are suddenly recognized following some unusual intra-abdominal strain and which have been attributed to a great variety of causes, *e.g.*, coughing, straining, lifting, sudden falls. It is this group which furnishes all the medical legal difficulty and the many knotty problems that have come before the Compensation Commissions and the Courts. The relative number of cases that come in this group is about 25 per cent. of all cases. . . . Hutchinson estimates it at 75 per cent. in adults.

Doctor Coley in an address, read before the New York and New England Association of Railway Surgeons, November 14-15, 1907, reported upon 4797 cases of hernia in males, personally observed, of which 3102 cases attributed the hernia to no one cause, while the remaining 1695 cases, the following causes were given by the patient: 1015 lifting weights; 150 coughing or sneezing; 123 push, fall or twist; 27 straining; 89 fall; 34 slipping; 40 blow; 8 kick; 20 running or jumping.

In a goodly proportion of cases, *i.e.*, nearly 25 per cent. of the total of hernia of effort the cause of the hernia was believed to be lifting or carrying some weight. I think it is fair to assume that in the majority of these cases in which the hernia appeared directly after some unusual effort, there existed some relation of cause and effect. Yet, we may still here assume the presence of a preformed sac, latent and empty up to the time of the unusual effort which increased the intra-abdominal pressure to such an extent as to force a portion of omentum or bowel into the empty hernial sac, thus producing an actual hernia. We must not forget that a sac which had been up to the time of the accident without contents does not constitute a true hernia. There must be, or must have been, something in the sac to make it an actual hernia, and just here is where the wide divergence of opinion arises, one group of writers considering with Kingdon, that a

hernia is always a disease, the other group regarding it as always due to an accident. Neither side is quite correct. . . .

3. In the third and by far the largest group, made up of three-quarters of all cases, the hernia has developed so slowly and without any local injury or accident, that the person frankly states he knows no cause to which he can attribute it. This group of cases it is quite fair to regard as due to developmental defects and in the nature of a disease rather than an accident. All agree that none of these cases is compensable.

To go back to group 2, Industrial Hernia, Hernia d' Effort and Accidental Hernias: Are these cases compensable and if so, what are the criteria upon which to decide whether they are or are not?

In our former report we attempted to show that in practically all of these cases of oblique inguinal hernia, the hernia was due chiefly to the presence of a preëxisting congenital sac which had remained without contents until the gradual and repeated strains incident to daily routine or occupation caused a gradual dilatation until large enough to receive a little omentum at first and later a portion of the bowel.

That a hernia of considerable size and with both bowel and omental contents can exist and often did exist without any symptoms and without the person's knowledge has been definitely proven. If by reason of some sudden and unusual strain associated with a fall or heavy lifting, a larger portion of bowel or omentum is forced into this preëxisting sac, pain and discomfort may follow. The patient feels of the parts, finds a lump and goes to his physician who diagnoses a hernia and the man honestly believes it was definitely caused *de novo* by the accident in question.

The Committee held the view that in such cases the hernia existed before the accident which merely enabled the man to recognize a condition that was present and emphasized the need of operation or proper treatment. We are quite willing to admit that in certain States, the mere fact that the accident caused some aggravation of a hernia already present, might warrant considering it compensable.

Many large industrial corporations have recognized the fact that they have very definite obligations to keep their employes in the best physical condition possible and that from a selfish point of view alone it might be to the advantage of the company to take a man who by reason of his hernia and without regard to responsibility for its causes is able to render only 75 per cent. of his capacity, pay his board in a hospital for two and a half weeks to pay a small surgical fee of $50.00 to restore him to 100 per cent. working capacity. Therefore, some corporations have adopted the practice of giving any employe who develops a hernia while at work for the company an operation and hospital expenses without cost to him.

Inasmuch as most companies have adopted physical examinations on entrance to service, these will be the only cases that will have to be taken care of by the company and it will be found they will be comparatively few in number.

We are inclined to believe this may be the best solution of the problem. In fact in our last report in our third recommendation we suggested practically this method of dealing with these cases. In other cases in which the corporation will not adopt this liberal method of dealing with hernia d' effort, what is the best plan to pursue? W eare inclined to believe that Rule 3 of the Nevada Commission or Doctor Mock's three rules, probably the best, and they will safeguard the employer against any large number of compensable cases. At the time we made our earlier Report, most of the cases of hernia were dealt with in the Courts and many fraudulent claims had been made and often large damages awarded.

Doctor Coley recalls one case in his own experience in the New York Central Railroad Company in which a man was in a slight collision; no one was seriously injured but this man claimed to have been thrown against the seat in front and produced a large double oblique inguinal hernia. Any person with any large experience in hernia would not hesitate for a moment to state that both of these hernias had been of long duration, probably two or three years, and it is quite impossible that either was caused by the injury in question, and yet a jury gave an award of $15,000 in this case, which, however, was not sustained in the Court of Appeal.

In those days, it was generally believed by the juries that hernia was often caused *de novo* by the accident and hence the large damages. At present both Courts and Compensation Boards have come to recognize the main contention of the Committee, *viz.,* that a hernia is almost always of slow formation and not due wholly to a single accident or strain and that the most that can be claimed is an aggravation of an already existing trouble. This is shown by the very small awards recently allowed by Compensation boards. In the Glen Alden cases there was a total award of about $144 given in each case.

If the report of the Committee has accomplished nothing more than this great change of viewpoint on the part of the Courts and Commission Bureaus, we believe the Committee well rewarded for all its trouble.

It will be seen from the foregoing that it is very difficult to accurately define in a few words, accidental or compensable hernia. The definition of accidental herna given by Mr. T. H. Carrow, Superintendent of Safety, Pennsylvania Railroad, at the opening of this report is very good and in harmony with the views of our Committee. The definition given by Doctor Mock just quoted is perhaps even better.

THE TREATMENT OF ELECTRIC BURNS BY IMMEDIATE RESECTION AND SKIN GRAFT*

By Donald B. Wells, M.D.
of Hartford, Conn.

Electric contact burns differ from all other types of burns in four major characteristics: (1) The heat which produces these burns is far more intense than the heat which produces any other type of burn; and this heat is usually applied for an infinitely shorter space of time than the producing heat in any other type of burn. (2) As a result of this intense heat, often of only instantaneous duration, a pathological picture is found radically different both in its gross appearance and in its microscopic detail from the pathological picture of any other type of burn. (3) This unique pathological picture gives rise to a natural history and clinical course materially different from that observed in ordinary burns or scalds. (4) Based on the foregoing considerations a radical method of treatment has given results which, so far as we have been able to ascertain, have not been secured by any other method employed.

Fig. 1.—Diagram illustrating difference between a flash burn and a contact burn.

This intense heat, distinctive pathological picture and characteristic clinical course are only observed in electric contact burns. They are not found in the so-called flash burns. The distinction between a flash burn and an electric contact burn is clearly shown in the first figure. A flash burn may be sustained when an electric arc is formed between two poles close to the body. The severity of the burn sustained will depend upon the proximity of the tissues to the electric arc and the length of time that the arc is maintained. Such a burn does not differ in any material way from an ordinary burn or scald, the intense heat of the electric arc being disseminated over a relatively large surface area and diminished in geometrical ratio proportionate to the distance of the tissue from the electric arc. By contrast, in the case of an electric contact burn, the type of electric burn which we are considering, the surface of the body forms one of the poles of the electric arc. The electric current passes through the body and the degree of heat attained at the point on the surface of the body where

* Read before the Connecticut State Medical Society, May 22, 1929.

the contact is made is the temperature of an electric arc. If a burn is produced, no matter how small, an electric arc must have been formed. If the contact is so perfect that sufficient resistance is not introduced to develop an electric arc, the body simply sustains an electric shock, which may produce anything from a slight tingle to instant death.

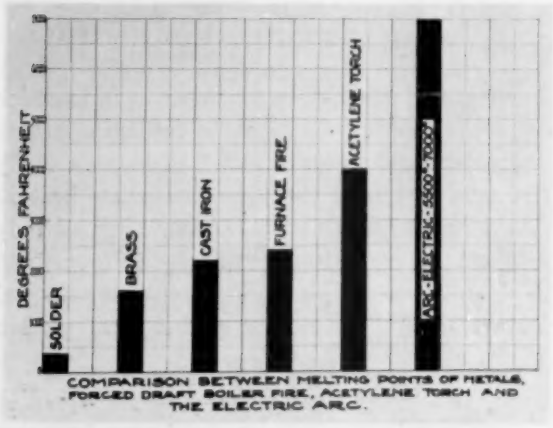

FIG. 2.—Diagram comparing melting points of solder, brass, and cast iron with temperature of the electric arc.

The second figure shows the relative temperature of an electric arc as contrasted with the temperature of other forces which may produce burns. The intractable character and long drawn-out clinical course of metal burns is well known; yet the melting point of cast iron is only 2200 degrees as contrasted with the temperature of an electric arc, which varies from 5500 to 7000 degrees. The acetylene torch, which will cut through the plates of a battleship, is 1000 degrees less than the minimum temperature of the electric arc. No wonder that the electric arc melts every body tissue, even bone.

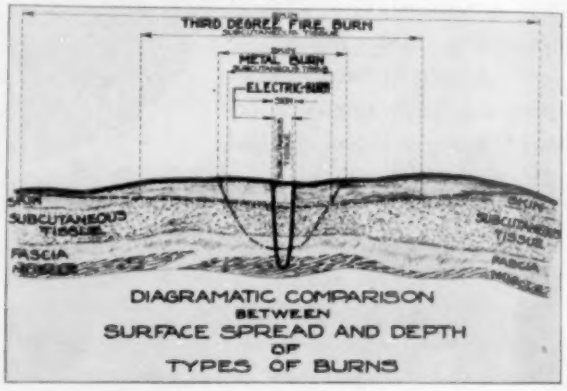

FIG. 3.—Diagram illustrating relationship of surface spread to depth of various types of burns.

This intense, almost incomprehensible heat results in a pathological picture which is characteristic. The size of the burn and perhaps certain secondary features, such as may result from ignition of the clothing, for instance, depend upon whether the electric arc was a single flash or continued for a perceptible length of time. Upon casual inspection the victim of an electric contact burn may present simply a single small blister. More often, particularly when the palmar surface of the hands is involved, the macroscopic lesion consists of a number of isolated discrete blisters. These look insignificant; and we have seen a patient discharged from the Accident Room by a House Officer who had no idea that the burns were serious, as the external manifestations appeared so trivial. But, if the superficial blister is carefully cut away, even the smallest electric burn presents a characteristic appearance. In the smallest burns there is a central area of white necrosis, often not more than a quarter

of an inch in diameter, surrounded by a narrow ring of hyperæmia. Larger electric burns present a central excavated area—dry, crisped and bloodless where the tissue has been absolutely burned away. This central excavated area is always surrounded by the characteristic zone of pallor, or white necrosis, which in turn is encircled by a narrow ring of hyperæmia or œdema.

The second characteristic feature of the gross pathological picture of an electric burn is the relationship of surface spread to the depth of the burn. This is diagrammatically shown in our third figure. The ordinary third degree fire burn, such as might be sustained if one's clothing caught fire,

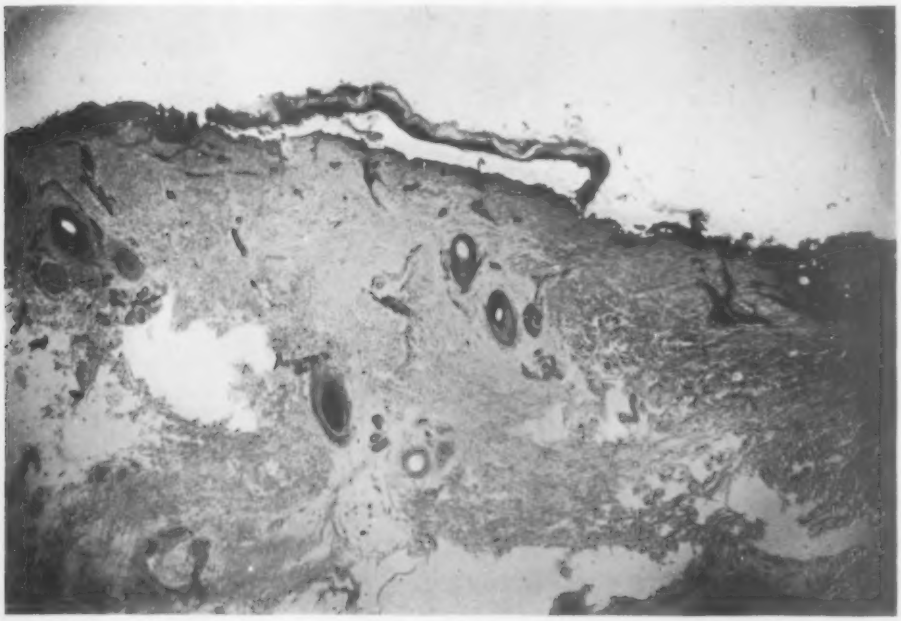

FIG. 4.—The specimen is a fusiform piece of skin 3½ by 2 cm. and with the subcutaneous tissue is 7 mm. in thickness. In the centre of the skin there is a shallow ulcer crater, 1½ cm. in its greatest diameter. The base of the ulcer is covered by a black deposit. The margins are somewhat retracted, but not definitely undermined. There is no thickening of the epithelium. On section the skin is of ordinary appearance at the margin. In the central portion the epithelial layer is absent. There is no induration at the base of the ulcer and the black pigmentation extends only a slight distance beneath the surface. (K.) *Microscopic.*—At the margin the surface is covered by a normal stratified epithelium. At the area of ulceration the epithelium is absent and the underlying structures for a considerable depth show complete necrosis. The cellular architecture is still preserved though none of the cells stain normally. There is no œdema and no inflammatory infiltration. This area of necrosis is quite sharply demarcated on all sides. At the margin of the ulcer the superficial epithelium is necrotic and slightly separated from the underlying tissue. (K.)

covers a relatively large area. A wide peripheral ring of erythæma, an intermediate circle of vesication and a central area of slough—all three areas ill-defined, merging into each other, relatively widespread over the surface and seldom extending deeply into the subcutaneous fat—these are the characteristic features of an ordinary fire burn. A metal burn, on the contrary, is ever so much more circumscribed. There is a comparatively narrow peripheral ring of erythæmia and vesication with a fairly well-defined central area of necrosis almost invariably extending well down into the subcutaneous areolar tissue. The electric burn stands out in marked contrast, sharply circum-

scribed, only the narrowest ring of erythæma surrounding a dead white central area of necrosis which always extends well into the subcutaneous tissue, often includes the muscle and tendonous structures and sometimes even bone. To be sure, the necrotic area is seldom perfectly cup-shaped; the necrosis tends to follow the direction of the current, is irregular in outline and often surprisingly extensive. But the necrosis is strikingly well-defined and sharply circumscribed.

FIG. 5.—Electric burn of arm.

The fourth figure, a microphotograph of an horizontal section through an electric burn resected within a few hours of the time it was sustained, clearly shows all these distinctive pathological features. Note the circumscribed character of the burn. Here are normal, living cells; and here, not an eighth of an inch away, are cells which are certainly dead. Note the relative depth of the burn in proportion to its surface spread. Note the homogeneous, poor staining, melted appearance of the cells, though the architecture can still be distinguished. How obvious that every bit of this slough must be thrown off before the burn will heal and how certainly this process will be slow, long drawn-out, tedious to the patient and discouraging to the surgeon.

FIG. 6.—Electric burn of foot.

The discouragement suggested by this pathological picture is borne out in the natural clinical history of electric burns. As a rule, in from thirty-six to forty-eight hours, an electric burn loses its dry, crisped, circumscribed

appearance to become a serum-saturated area with disintegrating walls and floor, progressing to profuse purulent secretion, gross sloughs bathed in pus, exuberant granulations—a disorganization impossible to check with the most radical antisepsis or scrupulous asepsis. This disorganization may include muscle, tendon, joint capsule, even bone itself. After a varying period, always from a clinical standpoint apparently unduly tedious and prolonged, firm granulation ultimately ensues and the final result will be as good as is ordinarily secured in other comparable burns.

FIG. 7.—Electric burn of foot.

FIG. 8.—Same arm as shown in Fig. 5 at first dressing on fourth post-operative day.

The complete resection of gunshot wounds, more usually spoken of as débridement, and their immediate closure by primary suture or their delayed closure after a few days of chemical sterilization, was a technic developed and perfected during the World War. The application of this principle of complete resection and immediate closure by suture or skin graft to third degree electrical burns has not been reported in the literature, nor has it apparently ever been successfully applied so far as we have been able to learn after diligent inquiry among surgeons who must come into frequent contact with the results of electrical traumata. But a consideration of the pathological picture, the unsatisfactory results of expect-

ant treatment and some experience with the débridement of gunshot wounds during the World War encouraged us some time ago to attempt to apply this therapeutic principle to electric burns. The results were surprisingly and uniformly satisfactory, so much so that we would not, by choice, consider any other method of treatment where this particular method is applicable.

The method has its limitations; the line of demarcation may not be sufficiently clear in tendons, cartilage or bone to warrant an immediate resection of the eschar. As always, discretion is the better part of valor. Essential structures, such as large vessels, nerves and joints should certainly be spared, if there is any doubt in the operator's mind as to their possible viability. But experience has taught us that the great majority of electric

FIGS. 9 and 10.—Condition of case shown in Fig. 7, three weeks after disarticulation of toes and skin grafting.

burns are far more successfully handled by complete resection and immediate closure by suture or skin graft, than by any other method.

During the past three years we have had a small series of electric burns treated by complete resection and closure of the wound, either by primary suture or immediate skin graft. Two typical cases may be recorded as representative of the results obtained by this method of treatment.

Our first case, Mr. D., represents the ideal treatment—complete resection of the eschar and immediate suture of the wound. He was "hung up" on July 22, 1927, when he came in contact with an 11,000-volt current. He was not rendered unconscious. The principal burn on the anterior aspect in the lower third of the left thigh was about one inch in greatest diameter. This eschar, and one of four smaller wounds, was resected and closed by primary suture. Fig. 4, to which attention has previously been called, is a microphotograph of an horizontal section through the larger of these burns. He was discharged from the hospital the day following the operative procedure; the sutures were removed a week later; and he was climbing poles sixteen days after he had sustained the burns.

Our second case, Mr. N., sustained the most extensive electric burns that have come under our care since this method of treatment was undertaken. He was "hung up"

on the top of a pole on June 18, 1927, when he came in contact with a current of 4800 volts. A fellow employee, two poles away, saw him sizzling up among the wires, ran a distance of some three hundred feet, climbed the pole on which Mr. N. was "hung up," knocked him loose, and lowered him to the ground where others instantly began artificial respiration. Mr. N. was conscious and oriented when we saw him at the hospital. There was an eschar in the lateral aspect of his left arm, involving the triceps muscle and insertion of the deltoid. Fortunately the musculospiral nerve had escaped injury. The extent and typical character of this burn are rather inadequately shown in Fig. 5, a photograph made in the Accident Room on his admission. The right great toe was practically burned off. The second and third toes were badly burned and the fourth toe superficially involved. The injury to the right foot is shown in Figs. 6 and 7.

FIG. 11.—Same arm as shown in Figs. 5 and 8 completely healed six weeks after burn was sustained.

Three hours after the burns had been sustained the entire eschar in the arm, including the area of white necrosis, was resected *en bloc*. This included about a third of the triceps muscle and part of the deltoid. The bleeding was completely controlled by innumerable fine ties and hot towels. Thiersch grafts were then cut from both thighs and the operative wound, which actually measured eleven by seven inches, completely covered. Our courage somewhat failed when it came to the foot; the great toe was amputated through the lower part of the first metatarsal; parts of the next three toes were removed; and transverse parallel slits were made through the necrosed skin and subcutaneous tissues on the dorsum of the foot.

FIG. 12.—Comparative view of the two arms to show the depth of the burn.

Fig. 8 shows the arm at the time of the first dressing on the fourth post-operative day. Unfortunately a large graft was pulled off the very center of the wound in removing the dressing, which consisted of silver foil immediately overlaid with gauze. We have since improved on this

dressing, and now use silver foil overlaid with a layer of paraffine mesh and vaseline gauze, which anchors down the foil and prevents the gauze from sticking to the graft.

On July 8, twenty days after the first operation, the second toe was disarticulated at the metatarsophalangeal joint, the gangrenous tips of the third and fourth toes removed, and about one hundred and forty small deep grafts were cut and applied to the granulating area on the foot. The result of this procedure is seen in Figs. 9 and 10 which show the result twenty-three days later, when Mr. N. was discharged from the hospital.

Figs. 11 and 12 show the arm on the day Mr. N. was discharged from the hospital, exactly six weeks after the burn was sustained. All dressings had been omitted from the arm five days previously (July 25). The man returned to work August 15, exactly eight weeks from the day he sustained his burns, and climbed a forty-five foot pole as a demonstration of his condition. Fig. 13 shows the absence of operative reaction or any

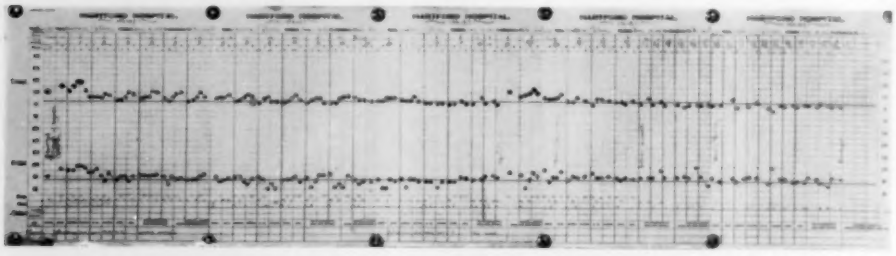

FIG. 13.—Temperature chart of second reported case.

fever which might suggest the slightest post-operative septic absorption from the wound. This is in marked contrast with the chart of a recently reported case, where death followed six days after a comparable electric burn from sepsis and exhaustion.

Summary.—Third degree electric burns are always sharply circumscribed, and the line of demarcation between the necrosed and normal tissue is as clear and distinct as it is in a case of gas bacillus infection. If the eschar is treated expectantly, it is certain that a deep slough must separate completely before the wound can heal. On the other hand, the eschar can be often resected *en bloc* and the resultant wound closed by primary suture or immediate skin graft, with great saving in suffering on the part of the patient, a material shortening of the period of immediate disability, and ultimate conservation of the functional capacity of the injured part.

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SUBCUTANEOUS STREPTOCOCCUS GANGRENE

By John T. Bate, M.D.,
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In this paper we wish to call attention to one type of gangrenous involvement of the vulva, rather than discuss all the local infections and systemic diseases which may result in gangrene of the vulva.

Our attention was called to this subject by a post-mortem examination performed on the body of a patient at the Louisville City Hospital.

E. G., No. 68109, female, married, colored, twenty-six years of age, was admitted to the hospital February 7, 1926, complaining of vaginitis from burns caused by a douche. There is a history of profuse, yellow vaginal discharge of about three weeks' duration. Upon the advice of friends, a hot douche of alum and bluestone was used one week ago. Following this, the patient was very sick and weak from pain. Instead of getting better, she has become progressively worse.

Fig. 1.—Subcutaneous streptococcus gangrene involving vulva and abdominal wall. The shaded area indicates the extent of the subcutaneous gangrene.

When admitted she was evidently in a serious condition.

The temperature 104.6° F., pulse 140 to the minute, and respirations 40. On the right and left sides of the lower abdomen there is much tenderness to palpation. The external vulval parts are somewhat reddened, with erythema of the adjacent skin of the thigh and lower abdomen. No pelvic examination was made. The vaginal mucosa was reddened and superficial ulcerations were present. Chest examination negative.

By the fifth day in the hospital a gangrenous area, measuring five by three centimetres, had developed in the left inguinal region. When opened a thin, purulent fluid escaped. Some small skin areas over the vulva appeared necrotic.

A blood examination made during her second day in the hospital gave: Leucocytes 16,200; polymorphonuclear cells 76 per cent.; red cells 3,680,000; hæmoglobin 75 per cent.

Urine.—Albumin four plus. Loaded with red cells and pus (not catheterized).

The temperature fluctuated between 104.6° F. daily, tending to become lower. The day of death it varied between 102° and 97° F. She died on the tenth day after admission.

Post-mortem Report.—In the left inguinal region is an ulcerated, necrotic area five centimetres in greatest diameter which exudes greenish-yellow, purulent fluid. (Fig. 1.)

Vulva œdematous and necrotic. Subcutaneous tissues about ulcerated area in left inguinal region are necrotic and undermined, extending to the posterior axillary line on the left, nipple line on the right, up to the level of the umbilicus and down to the pubic. The necrosis does not extend through the anterior muscle sheaths, being limited to the subcutaneous tissue.

Cultures and smears taken from the necrotic subcutaneous tissue showed a pure culture of streptococcus hemolyticus. Unfortunately these streptococci were lost during transplantation before experiments could be performed to see whether or not they possessed a selective action on subcutaneous fat and fascia.

The illustration shows the area of greenish-brown gangrenous skin, and the area over which the subcutaneous fat and connective tissue was necrotic, while the overlying skin was intact. This area extended from the umbilicus to the anus. There were only small areas of skin necrosis on the vulva.

Etiology.—During work on the wards of a large general hospital, we have seen three cases of subcutaneous gangrene. The first occurred in a German, fifty-five years of age, who first presented himself with three small areas of gangrenous skin on the outer side of the right foot, outer side of the right ankle and the dorsal part of the right leg. The lower third of the right leg was reddened and swollen. The lymphatic glands in the popliteal space were slightly enlarged and painful. There was a faint trace of albumin in the urine and the blood sugar was ninety-five milligrams per 100 cubic centimetres. A culture from the wound showed a pure growth of streptococcus hemolyticus. The blood culture was negative.

For two months conservative treatment consisting of multiple incisions and Dakin's tubes was followed. The process extended continuously following the subcutaneous tissue and the fascia between the muscles. The thigh was then amputated at the juncture of lower and middle thirds. Even then great difficulty was experienced in checking the infection. He was finally discharged as cured 186 days after amputation.

The pathological report of the examination of the amputated leg was as follows: There is extensive sloughing of the skin, subcutaneous tissue and fascia between the muscles. These areas have indolent margins and there is sloughing beneath the surface of the undermined skin. There is no evidence of healing. These areas are confluent and leave much of the muscle and bone of the calf exposed.

The second case [1] was a white, American, male, forty years of age, with extensive involvement of the right arm. This member was swollen to twice its normal size. It was dark red in color; the brawny induration and redness extending into the tissue over the deltoid muscle. On the flexor surface of the right forearm were several areas where the skin was greenish-yellow in color, due to necrosis. There were a few bridges of healthy tissue separating the sloughing areas. The total area measured approximately twenty-five by six centimetres.

At an emergency operation performed by Dr. H. H. M. Lyle, the sloughing skin was removed, the skin edges raised and the necrotic subcutaneous tissue dissected out until living tissue was reached. This neces-

sitated raising the skin for several centimetres in all directions. Hydrogen peroxide was used to clean the denuded areas and Dakin's packs were applied. This same method was used whenever a devitalized area appeared.

Using general surgical methods, this man recovered completely with a perfectly functioning arm.

A pure culture of streptococcus hemolyticus was obtained from the wound.

The third case was that of an Italian, about fifty-five years of age, who was markedly prostrated and who presented a scrotum swollen to the size of a small grape-fruit, dark red in color with several areas of greenish-brown skin necrosis. The penis was similarly involved and the brawny redness of the skin extended onto the abdomen for a distance of twelve centimetres. A No. 22 Charrière soft catheter passed easily into the bladder. He died within twenty-four hours. The medical examiner, without seeing the body, directed that a diagnosis of erysipelas of the genitalia be assigned as the cause of death.

Meleney [2] has written a very thorough article describing a group of cases characterized by a rapidly developing gangrenous process from which only the hemolytic streptococcus can be recovered with regularity. Pfanner [3] had previously reported such a case of gangrene of the extremity and Siemann,[4] Hawkins,[5] Stirling,[6] and Campbell [7] had described cases of this affection of the scrotum. Meleney studied seventeen cases personally and collected three cases from the records of the Union Peking Medical College Hospital. The disease usually occurred in males, probably from contact with dirt, although there was usually a history of a minor injury. In his series, the incidence was the foot, six; the leg, three; the thigh, one; the forearm, four; the arm, three; the hand, one; the chest wall, one; the penis and scrotum, one.

Clinical Course.—This is alarmingly rapid. Usually within twenty-four hours after the appearance of the original lesion, the affected member becomes greatly swollen, hot, red and tender, with symptoms and signs of acute inflammation spreading rapidly. The temperature quickly increases. It may be preceded by a chill and is almost always followed by profound prostration.

The early swelling makes the skin tense, smooth and shiny. The redness is usually diffuse and gradually shades off into normal color at the margin. In a day or two, certain areas gradually turn darker, changing from red to purple and then to blue. About this time blisters begin to form in which clear, yellow fluid collects. Usually, on the fourth or fifth day the purple areas of skin become frankly gangrenous. They first become black, then greenish-yellow. From the seventh to the tenth day, the line of demarcation becomes sharply defined and the dead skin begins to separate at the margin or break in the centre, discharging pus and revealing extensive necrosis of the subcutaneous tissue. Sometimes the area of skin necrosis is very small, while the subcutaneous gangrene is very extensive.

Up to the time the dead skin separates, fever continues, prostration increases from day to day.

Lymphangitis is rare in this condition and in only a few cases is there any enlargement of the regional lymph glands. Occasionally, there is a phlebitis of neighboring veins. In one of Meleney's cases erysipelas was present at the site of infection and a few days after admission it developed on his face without subsequent necrosis there.

Erysipelas may arise, however, after the gangrenous process has subsided. This occurred in two cases of Meleney's series.

Pfanner reports that all of his cases began as erysipelas and that gangrene was secondary. He calls the disease "necrotizing erysipelas." He writes: "The subcutaneous necrosis extends about a hand's breadth above the erysipelas. When early incisions are made to the limit of the subcutaneous necrosis, the erysipelas goes no further and the progress of the necrosis also stops."

In more severe cases, the process continues to advance rapidly until several large areas of skin have become gangrenous and the intoxication renders the patient dull, unresponsive, mentally cloudy or even delirious. About this time, pulmonary symptoms and signs denoting bronchopneumonia or lung abscesses may develop. Metastatic abscesses may appear at any point, but chiefly in the subcutaneous tissue.

Hemolytic streptococci were grown from the blood of seven to seventeen cases reported by Meleney. The blood culture was positive in three of the four fatal cases.

Stirling reported a case of gangrene of the scrotum and penis. A circumcision had been performed. This was followed by a slight infection for the relief of which the patient applied a strong solution of mercuric chloride. The next day the skin of the scrotum was dead. Within a few days the skin sloughed. A wound culture showed streptococcus pyogenes.

In the French literature several cases of scrotal and vulval gangrene, which followed the use of strong mercury bichloride douche, were reported. The bacteriological examination usually showed fusiform bacilli and spirilla, or evidence of a mixed infection. There was little tendency toward subcutaneous necrosis, so these cases do not belong to the group we are reporting.

In some cases and, in the one we are reporting, it seems probable that the injury caused by the strong medication served as a starting point for the infection with this type of streptococcus, or else aggravated a lesion already existing.

Campbell reports five cases of scrotal and penile gangrene. In each instance, the disease was characterized by an abrupt, apparently spontaneous onset, a rapidly ensuing inflammation, with marked œdema and subsequent necrosis of the superficial tissues of the genitals. The disease was accompanied by sepsis and prostration. Physical debility, associated with a variable degree of body filth, is usually present. The streptococcus hemolyticus was

cultured in each instance and was the probable causative agent. Campbell thinks the condition is closely related to erysipelas.

While many gangrenous lesions due to various other organisms have been described in the literature, we are speaking only of streptococcus gangrene in this paper.

A search of the literature by Campbell revealed but six cases of scrotal erysipelas. In these, the onset and course of the disease coincided well with that of "idiopathic" gangrene. These cases were reported by Randall.[8] Nélaton [9] noticed a case following a slight incision of the frenum. Erysipelas of the face and arm occurred four days after the onset of the scrotal condition in one of Campbell's cases.

Prognosis.—A mortality of between 20 and 25 per cent. can be expected. Four of the seventeen in Meleney's series died. One of Campbell's cases died. Whiting collected ninety-three reported cases of scrotal involvement with a mortality of 23 per cent.

The Literature on Vulval Gangrene.—Taussig [10] writing in his monograph, Diseases of the Vulva, does not discuss streptococcus gangrene as an entity, but under erysipelas of the vulva, he says: "I recall years ago seeing erysipelas of the vulva in association with an epidemic of scarlet fever and puerperal sepsis in a maternity hospital. Localized gangrene and death resulted in this case." In discussing gangrenous vulvitis or noma, he says: "When found in adults, gangrenous vulvitis usually follows some virulent wound infection."

Brissaud and Sicard [11] report the case of a woman in good health in whom a blister appeared on the right labia majora. On the third day the pain irradiated into the vulva. There were no enlarged lymph glands in the groin. There was a serosanguineous discharge from the vulva and on the following day there were bilateral blackish sloughs. The gangrene was very rapid. The temperature was 98.4° F. On the fifth day the gangrene spread and the odor was foul. The patient died on the seventh day with a temperature of 105.8° F.

The urine had never had sugar nor albumin. The blood cultured on the fifth day, gave a pure culture of streptococci.

Lugeol [12] reported a case in which gangrene of the vulva followed erysipelas of the hands and face: A woman, thirty years of age, vigorous, healthy and happy, developed erysipelas of the face which lasted a few days and ran regularly through its various stages. She was believed to be well when she noticed that the labia majora were swollen and on each side there was a spot of gangrene. At the medical meeting where this was reported, Dupont [13] reported a case of a young woman, who had gangrene of the vulva at the termination of erysipelas of the face.

The editor of the journal, in which the above was reported, refers to an article in the "Dictionnaire de Chirurgie Pratique" where gangrene, at the site of the erysipelas, was noted in very severe cases.

Since writing this article, Fallon [15] has reported a case of streptococcus subcutaneous gangrene involving the breast.

Discussion.—From our observation upon two living cases of involvement of the extremity, one of the scrotum and the one post-mortem examination of the case of gangrene of areas of the vulva and the subcutaneous tissue of the abdominal wall, and from our study of the literature, we believe that

one is justified in concluding that there is a type of infection which is caused by a streptococcus which has a definite predilection for attacking the subcutaneous fat and fascia. There have been frequent observations by various competent observers that there is a relation between this type of infection and erysipelas. Erysipelas has been observed to accompany the streptococcus gangrene, to precede it and to follow it.

Three cases of gangrene of the vulva from which the streptococcus has been isolated have been reported in the French literature.

This report is being made to draw attention to our belief that the same type of infection reported by others as affecting the extremities and scrotum, may also involve the vulva and extend to the abdominal wall.

Treatment.—Palliative treatment must be followed until a gangrenous area appears. Then it is necessary to dissect away all of the dead tissues. When the subcutaneous tissues are necrotic beyond the limit of the superficial gangrene, the incision must be extended until the necrotic tissues are excised. When possible, the incision should not extend into the zone of cellulitis. However, the subcutaneous veins should be spared, as they are usually not thrombosed and supply areas of living skin. Hydrogen peroxide aids in cleaning away the pus and débris and also tends to stop the oozing of blood. Dakin's solution is used to dress the exposed areas.

As the wound becomes clean, the healthy granulation will fill in, the undermined skin will become attached and skin grafting can be resorted to where necessary.

Meleney recommends hot applications with water or normal saline, 40° to 45° C. (104° to 107° F.). After the cellulitis has disappeared, he advises Dakin's solution. He does not wait until the wound is free from streptococci before grafting skin. When the epithelium at the edges of the wound begins to grow, the wound is ready for graft.

Antistreptococcus serum was not used in Meleney's nor Campbell's series. Since then, great progress has been made by Simmers and Lewis [14] working at Bellevue Hospital with a serum made, according to the method of Birkhaug, from streptococci isolated from erysipelas cases. The mortality from erysipelas at that institution has been reduced from 12.1 to 5.3 per cent. It is obvious, therefore, that it is important for other observers to endeavor to ascertain whether or not there is a definite and constant relationship between streptococcus gangrene and erysipelas. A therapeutic test with the serum would be interesting.

I wish to thank Dr. Henry H. M. Lyle, of St. Luke's Hospital, New York City, for permission to mention the cases from his service at St. Luke's Hospital, and Dr. Charles W. Hibbitt, Chief Surgeon of the Gynecological Department, Louisville City Hospital, for permission to report the case from his service. I have used freely Dr. F. L. Meleney's description of the course of subcutaneous gangrene caused by the streptococcus.

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TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD OCTOBER 9, 1929

The President, Dr. Edwin Beer, in the Chair

ACUTE PERFORATED ULCER OF THE STOMACH

Dr. Paul Dineen presented a woman forty-five years of age, who was admitted to New York Hospital March 14, 1924, complaining of acute abdominal pain of four hours' duration. She exhibited a scaphoid abdomen and was tossing about with severe epigastric distress.

An immediate operation was done and on opening the peritoneum much gas and fluid escaped. A large ulcer with a perforation one-quarter inch in diameter, and an area of induration of one inch in all directions, was encountered two inches proximal to the pyloric vein and near the greater curvature. Simple closure of the ulcer was done. She made an uneventful recovery and left the hospital in sixteen days.

She still has occasional attacks of severe epigastric pain. X-ray examination reveals pylorospasm at these times. On questioning the patient it is found that these attacks are associated with some nervous upset, financial troubles or troubles with her family. As soon as her worries are removed her gastric condition is satisfactory.

Dr. Dineen also presented a man, twenty-eight years of age, who was admitted to the New York Hospital August 16, 1922, complaining of an acute, agonizing epigastric pain of three hours' duration. He was a thin, anæmic individual writhing in pain with a board-like, scaphoid abdomen. White cells were 19,600 with 86 per cent. polymorphonuclears. Urine negative. He was immediately taken to the operating room and a high right rectus incision was done. A small perforation, one-eighth of an inch in diameter, was found on the anterior surface of the duodenum, just distal to the pyloric vein. Simple inversion was done. Twelve days after operation he developed a most extensive ischiorectal abscess consequent to a fistula in ano. The abscess burrowed down the whole posterior aspect of the thigh and part of the leg. This abscess was opened widely. The man left the hospital ten weeks after entering. Since leaving the hospital he has occasional attacks of pylorospasm when he is overworked. Fluoroscopic examination at these times shows evidence of severe spasm that subsides in a day or two and then examination of the stomach and duodenum fails to reveal any lesion.

RESTORATION OF THE LOWER LIP AND PORTION OF CHIN

Dr. William F. MacFee said that a number of methods are available for restoration of the lower lip. In most of these methods, use is made of

the adjacent tissues of the face and neck, usually as flaps, to replace the missing lip. He presented two cases in which the extensive destruction of tissues, or previous scarring, made such methods impracticable. Recourse was made, therefore, to the tissues of the anterior chest wall.

The first case was a male, fifty-two years old, who was admitted to St. Luke's Hospital, May 2, 1926.

History.—About fifteen years ago, he first noticed a small elevated "spot" on the right side of the chin. It was frequently cut in shaving, and alternately was ulcerated and healed. No increase in size was noticed, but the patient became fearful that it might become cancerous and decided to have

FIGS. 1 and 2.—Appearance of patient after sloughing was complete. In the lateral view what appears at first glance to be the lower lip is really the tongue. Lower lip and gingiva are completely absent. A thin portion of mandible remains. Outline of flap is shown.

treatment. Between 1921 and 1925 four radium treatments were administered in another hospital. After the first treatment the lesion remained healed for thirteen months, then ulcerated again. After a second treatment it remained healed for six months. The third treatment was with a radium pack. Following this healing again resulted, but recurrence followed two months afterward. A "stronger" treatment was then given with the radium. This caused a mass of sores to form, first on the inside and then on the outside of the lip. Eight weeks were required for healing of the initial lesion and these sores. Nine weeks after healing the growth returned. The patient did nothing more for some time. He then consulted another doctor who told him he had cancer all over his lip, chin, and gums, and advised the

use of a paste. The doctor and a young man who provided the remedy came to the patient's house and applied the paste to his lip and chin, this being about five months after the last radium treatment. The paste was left on for twenty-four hours, and then "slippery elm poultices" were applied every two hours for six days. After removal of the cancer paste the lip and chin became "as hard as cement." The slippery elm poultices caused the area to crack and to begin to separate from the good flesh. Within a few days the tissues in the vicinity of the initial lesion came away, leaving the bone exposed. The doctor and the young man then saw more cancer under the edges of the skin and more paste was applied. The entire lower lip and adjacent structures sloughed away.

Examination.—The entire lower lip and the soft parts of the chin are missing, and the mandibular symphysis is exposed. (Fig. 1.) The gingiva has likewise been destroyed, and only a narrow stretch of tissue exists between the tongue and the posterior surface of the mandible at the point. Saliva drools freely from the mouth as the patient tries to retain it by pressing his tongue against the upper lip. The surface of the exposed bone is black and necrotic, but does not separate easily from the portion of bone which is still nourished. No evidence of cancer is seen in the wound edges, and nothing suggestive of cancerous lymph nodes is felt in the neck.

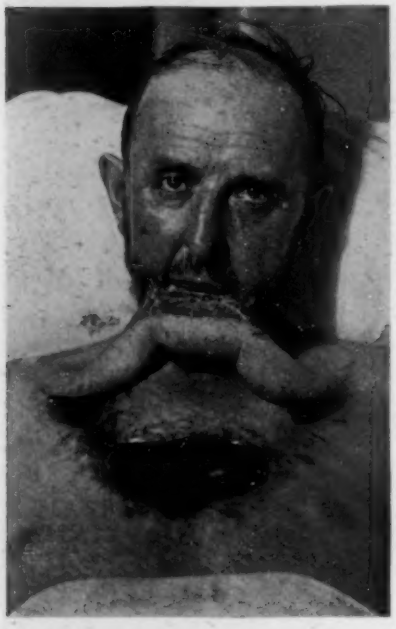

FIG. 3.—Flap with double pedicle is shown attached to chin. Some separation has occurred at the angles. The mucous membrane of the new lip is seen in the upper central portion of the flap.

May 12, 1926, the necrotic bone was removed.

May 26, 1926, an arcuate incision was made on the anterior chest wall, beginning near the junction of the medial and middle thirds of the right clavicle, extending downward at its lowest point to the level of the third rib, and then ascending to a point on the left clavicle corresponding with that on the right. A second incision parallel to the first was made three inches below the first. Both incisions were carried down to the underlying muscle. (Fig. 2.) The central eight inches of the flap, thus outlined, were elevated from the muscle and sternum. The underlying portion of the right pectoralis major muscle was divided transversely to its fibres, at a distance of three inches from the sternal origin. The left pectoralis major was cut in a similar manner. The muscle flaps, thus formed on either side, were then turned medially and sutured together in the mid-line over the sternum, in order to form a fleshy prominence which should serve as a new chin. The incisions were closed with silk.

July 1, 1926, the incisions were opened up, and a wider portion of the tentative flap was freed from the chest wall. The upper edge of the central portion was shaped to correspond as nearly as possible to the shape of the lower lip. The patient was then circumcised and the preputial mucous membrane was used as a full thickness graft to form the inner surface of the lip. This part of the procedure was suggested by previous work of Dr. Franz

Torek and Dr. H. H. M. Lyle. After the graft of mucous membrane had been sutured in place, the entire flap was returned to the chest wall.

July 14, 1926, the flap was freed completely from the chest wall, except at its two pedicles near the clavicles. The mucous membrane had taken well. It seemed safer not to attempt a transfer of the flap at this time. After minor adjustments, it was again replaced and sutured to the chest.

July 23, 1926, after the margins of the facial defect had been prepared to receive it, the graft was transferred from the chest wall to the chin and sutured in position. Both pedicles were left attached at the clavicles. (Fig. 3.) The open wound left on the chest was covered with a Thiersch graft.

FIGS. 4 and 5.—Present appearance of patient in natural pose. The lips which are held slightly parted can be completely closed.

August 6, 1926, the right half of the flap was divided at the outer margin of the facial defect. It was necessary to ligate both ends of a severed artery running in the flap. The lateral portion of the flap was returned to the chest wall. No attempt was made to revise the amputated portion attached to the chin.

August 18, 1926, the left half of the flap was divided. Several small vessels had to be ligated. The portion of the flap remaining was placed in its original position on the chest wall.

August 25, 1926, the raw ends of the graft were shaped and fitted into the facial defect.

September 22, 1926, patient was allowed home for a rest.

October 5, 1926, the patient returned to the hospital to have corrected a drooping of the lower lip, which prevented complete closure of the mouth. At the suggestion of Dr. H. H. M. Lyle, a strip of fascia was passed from the thigh transversely through the lip and its ends anchored in the upper, remaining portion of the orbicularis oris at the insertions of the caninus, zygomaticus, and buccinator muscles. This made possible an active, complete closure of the mouth.

May 4, 1927, on account of a remaining tendency of the lower lip to droop and to evert, a second strip of fascia was inserted in the lip and anchored as before, except that it was drawn more tightly. Considerable improvement resulted.

FIG. 6.—Appearance of patient after flap for lip reconstruction had been outlined on chest. A single pedicle was used in this case.

January 13, 1928, a triangular wedge of skin and tissue was removed from the lower portion of the chin to give a better silhouette. Figures 4 and 5 show the ultimate result of this work.

The second case was a man, fifty-eight years of age, who was admitted to The New York Skin and Cancer Hospital, March 26, 1927, with a history that he had been originally operated upon March 22, 1926, in another hospital. At that time, the lower lip was completely removed with the cautery for an extensive squamous-celled carcinoma. No attempt had been made to restore the lip. Previous to removal of the lip, he had had three radium treatments, September 17, October 1, and November 1, 1926.

Examination. — The patient has a healed scar resulting from complete removal of the lower lip. The skin of the chin below is united to the gingival mucous membrane. In the left submaxillary region, there is a hard lymph node two centimetres in diameter and about two and one-half centimetres below the skin surface. It does not seem fixed.

The patient was first operated upon by another member of the attending staff on March 31, 1927. Incisions were made at each angle of the mouth and carried laterally for a distance of about three centimetres. A curved incision was then carried from the lateral end of each incision downward to the mandible. The two flaps thus formed were swung forward and medially, and were united in the mid-line to form a new lip. Because of severe infection, the flaps separated, and the operation did not succeed. The result is seen in the first photograph.

The presence of scars in the cheeks precluded their use for further

attempts at cheiloplasty. The tissues of the neck were likewise undesirable material because of the possible presence of carcinomatous metastases, and because of the additional scarring which would result. A thoracic flap was therefore chosen. Before attempting to restore the lip, however, it seemed advisable to remove the lymph nodes from the left anterior cervical triangle, where a good-sized node was palpable. This was done April 27, 1927. The lymph node which had been palpable showed squamous-celled carcinoma with pearl formation and central necrosis.

Second operation, July 11, 1927. At this time, a flap was outlined on the chest wall in such a manner that its free end could be shifted to replace the lower lip. The pedicle was placed near the middle of the right clavicle. The incision was made to the depth of the pectoralis major muscle. Its medial half was completely elevated from the chest and was shaped to form

FIG. 7.—Shows flap attached to chin.

FIG. 8.—Appearance of patient after restoration; lateral view. The irregularity seen at the junction of graft with skin of chin has since been removed.

a new lower lip. Skin taken from the back of the right ear was used as a full thickness graft to serve as mucous membrane for the lip. After this was secured in place, the flap was returned to the chest wall and sutured there, to await development of better circulation before an attempt should be made to transfer it.

Third operation, July 25, 1927. The flap was completely freed except its pedicle. The graft from the back of the ear had adhered and the color of the flap was good. The chin was prepared to receive it, and the transfer was made. The mucous membrane of the new lip was sutured to that of the gingiva and the cheeks. The skin defect on the chest wall was covered by a Thiersch graft, taken from the thigh.

Fourth operation, August 19, 1927. The circulation of the grafted portion of flap was tested by compressing the pedicle. It seemed adequate and the flap was amputated at the right lateral margin of the labial defect. This

free end of the graft was fitted into the defect and sutured there. The remaining portion of the flap was returned to the chest.

Fifth operation, September 23, 1927, consisted of removal by dissection of the supraclavicular lymph nodes on the left side. A large adenoma of the left lobe of the thyroid gland was removed at the same operation.

Sixth operation, November 8, 1927. Removal by dissection of the lymph nodes of the right anterior triangle of the neck.

Seventh operation, June 21, 1928. Revision of grafted lip to make it fit evenly with the chin surface.

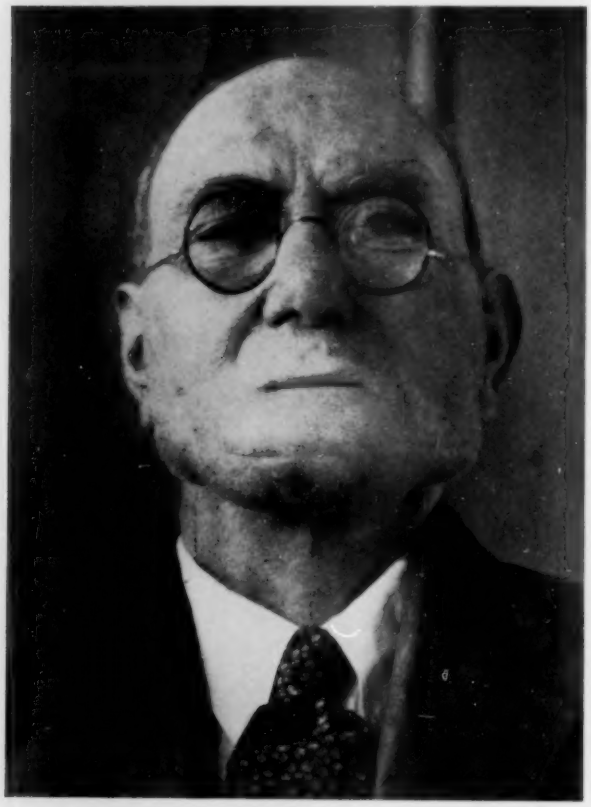

FIG. 9.—Appearance after restoration, front view.

DR. FENWICK BEEKMAN referred to a patient he had treated at Bellevue Hospital two years previous. A boy in an automobile accident had had his lower lip and soft tissues of the chin avulsed and a fracture of the symphysis of the jaw. A local physician had carefully débrided the wounds, removing all the lacerated tissues. Consequently, there was nothing left of the lower lip or the soft parts about the chin. The patient was admitted to Bellevue Hospital ten days after the accident. At that time the bone of the jaw was exposed. After consultation with the dental surgeons, the teeth were wired until the fracture had healed. The new soft tissues of the chin were reconstructed from lateral flaps, the mouth being widened by incisions on each side and the mucous membrane sewed to the skin. A well-fashioned lip was formed following the first operation, but there was a fistula beneath it. Six months later this was operated on and closed.

Doctor Beekman made a plea, in speaking of these cases, against the débridement of wounds of the face. The tissues of the face are so very vascular that it is not necessary and for future plastic work, no part should be needlessly sacrificed. Instead, any ragged tissue should be brought as far as possible into its normal position and allowed to heal, thus favoring a later plastic repair.

DR. HUGH AUCHINCLOSS had noted that these cases demonstrated per-

fectly the painstaking care necessary in dealing with these conditions. His own experience had been confined to restoration of contractures following burns and he had accomplished this by the use of flaps from neighboring parts, from the checks or from the arm in the deltoid region. He had carried flaps from the lower chest and abdominal wall by stages towards the neck and then grafted them to the contractured area.

DOCTOR MACFEE, in closing, said that as compared with those from the arm, chest flaps have the advantage of allowing the patient more mobility. These operations are done over several periods, and when using chest flaps the patients are able to be up and about the ward in the intervals. This adds considerably to their comfort and insures more willing coöperation from them.

MULTIPLE SPONTANEOUS FRACTURES

DR. CLAY RAY MURRAY presented a man with the following history: He was admitted to the Medical Service of The Presbyterian Hospital for the first time May 1, 1928, on account of rheumatism of fourteen months' duration. Six years ago he began to have pain and vomiting during and after meals. Describes pain as epigastric and pressing in character. Continued for two years, when after a sudden and more severe attack he was taken to a private hospital in Chicago and subjected to an emergency operation for perforated gastric ulcer. Was told that a piece of intestine had been removed. Since then has had relief from gastric symptoms. Pain, vomiting, and attendant loss of weight had been the only symptoms. While in the hospital, following operation, it was noted that he had ocular pupillary changes and a blood Wassermann was done which was negative. Wassermann at Neurological Institute negative about two years ago. Spinal puncture advised and refused. Is extremely "nervous." Has had occasional attacks of dizziness. Suffers from insomnia. Denies lues. Has had intermittent diarrhœa with incontinence for four years, relieved by courses of enemata.

Present illness.—Fourteen months before admission left ankle became swollen. Joint was hot and tender and patient felt feverish for a few days. In subsequent attacks other ankle and both knees were involved. Intervals between recurrent attacks became progressively shorter. Was treated by mouth medication and physiotherapy, and all teeth were extracted without relief. Some loss of weight and night sweats. Attacks of diarrhœa and incontinence in last seven months relieved by enemata. Seven months ago began to have constant difficulty in walking, and had to quit work. Legs felt "heavy as lead," feet dragged, and he kicked steps when walking up them and stumbled. No difference noted in the dark. For three months there has been pain across lower lumbar region and across the chest. No change in visual acuity. No gastric or urinary symptoms. No history of injury of any sort at any time.

On admission the positive physical findings were inequality of the pupils, right smaller than left, with very sluggish reaction to light, more marked right than left; markedly exaggerated but equal knee jerks; spleen palpable, and liver four centimetres below costal margin; left ankle uniformly swollen, slightly tender, not red or hot, without impairment of motion range; moderate abnormal bony prominence on os calcis below internal malleolus; dulness both apices with harsh breathing, and few râles over the left apex; slight swelling of right knee, not tender, no limitation of function, no fluid in the joint. Neurological examination revealed in addition to the pupillary changes some emotional instability and memory impairment, and some impairment

of pain and temperature sense in the legs, but was otherwise negative. Wassermann repeatedly negative. Spinal fluid was serologically negative, and showed no abnormality in cell content on two occasions. Temperature was normal. Red blood cells 4,340,000, hemoglobin 88 per cent., white blood cells 12,500, with normal differential. Chest X-ray negative. X-ray of the head showed some clouding of the sinuses, but was otherwise negative. There was some periostitis of the outer margins of both fibulæ, and of the inner margin of the right tibia. Gastro-intestinal series was negative for any evidence of pathology or of the existence of a gastro-enterostomy or other abnormality. There was a transverse fracture of the right fibula six centimetres below the upper end. There was in the left os calcis an oblique fracture with considerable bone production. This extended from the upper margin just posterior to the joint margin downward and forward through the mid-plantar margin of the bone. The joint margins were smooth. The process was apparently of some duration. These fractures accounted for the knee and ankle symptoms. There was no history of trauma. The medical staff and the neurologists felt that the story was one of central nervous system lues despite the sparse neurological findings and the negative blood and serology findings. His fractures were considered as pathological and as part of the recognized possibilities in tabes and spinal lues. His fractures were treated by protection by a brace, and he was put on antiluetic treatment with very marked improvement in his symptomatology.

On the 2nd of October X-ray reported firm union in the fractures and discovered a fracture of the base of the second metatarsal, healed. At this time he was walking with the short brace without a cane, and to use his own words, felt fine, had no pain, and the foot and knee were normal.

On October 15, 1928, fifteen days after the preceding note was recorded, he was admitted to the Fracture Service at the Hospital with the following story. While climbing the stairs carrying a suitcase he heard a snapping sound in the leg which he attributed to the brace he was wearing. He felt no pain or discomfort in the leg. Two or three hours later while resting in his room he began to have pain in the anterior part of his right thigh. This continued all day. He took a hot bath and applied oil of wintergreen. Noted no deformity or abnormality in the thigh. Pain was increased by walking and flexion of the thigh. Had to use a cane. The pain was worse the next morning and the patient went to bed where he stayed till admission. On afternoon of day of admission patient limped to bathroom in his home. The door bell rang and startled him, and he put his whole weight suddenly on his right foot. He immediately felt a severe pain in his right thigh, and a large swelling appeared. He supported himself by the nearest piece of furniture and by pressure caused the swelling to disappear. He got to bed, was seen by a local doctor, and sent to the hospital.

X-ray showed a fracture of the middle third of the shaft of the right femur with deformity. This was treated by traction suspension followed by a plaster spica, both of which the patient bore badly, and later with a walking caliper, which the patient removed early against advice. The course was characterized by a very slow union. Blood Wassermanns were again negative. Patient refused spinal puncture. Neurological consultation resulted in the same opinion as on previous admission. Antiluetic treatment resulted in no effect on the course of fracture healing that could be determined. The administration of calcium and irradiated ergosterol by mouth had no observable effect on the calcification process, nor on the blood phosphorus and calcium, which were normal throughout his course. All the long bones and skull were negative on X-ray. On the 2nd of January, 1929, the spica was

removed and a walking caliper applied. On March 8 the patient was going about without the caliper because of his business needs, driving a car. X-ray at this time showed a large amount of callus spread diffusely through the tissues, with decalcification of the shaft margins. There was considerable deformity due in part, at least, to the discarding of his brace at too early a date.

He was next admitted to the Fracture Service of the Hospital on July 3 of this year. While walking along the street he felt the left thigh snap, and immediately collapsed. Admission X-ray showed a spiral fracture of the upper third of the left femur. There was considerable displacement with one and a half inches overriding. He was again treated by traction suspension. Blood calcium and blood phosphorus have been normal. On September 5 it was noted by X-ray that there was no callus and that the shaft of the femur appeared porotic and that the cortices were thinned. A few days ago it was noted that although the X-ray of October 27 noted the appearance of only a very slight amount of callus at the bone ends, clinically the union felt fairly firm. He was therefore fitted with a caliper, and is to be allowed to walk as soon as the opposite shoe is raised to allow of locomotion.

This case is shown, not as a result of fracture treatment, but because of its peculiar features of excessive fragility of the bones, relative painlessness of injury and course, normal blood chemistry, normal serology, and scant neurological findings. In addition the problem has to be faced as to how further similar catastrophes can be avoided, if that be possible.

FIG. 10. FIG. 11.

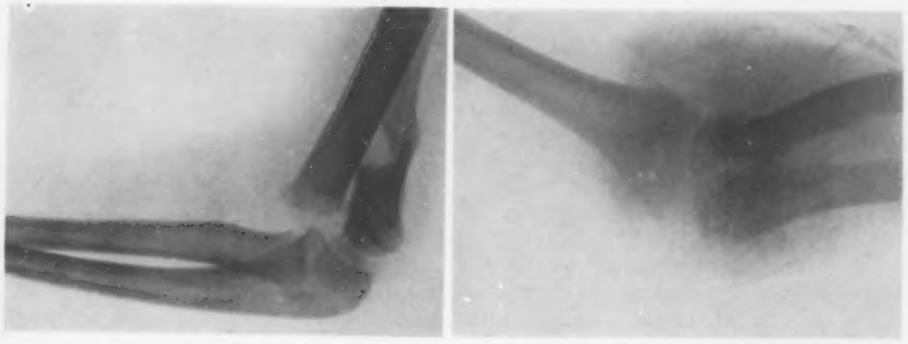

FIG. 10.—Anterior posterior view of supracondylar fracture showing displacement of lower fragment.

FIG. 11.—Lateral view one month following injury. Note callus formation in the periosteal tube and the obstruction to complete flexion by the lower end of the upper fragment.

SUPRACONDYLAR FRACTURE OF THE HUMERUS

DR. FENWICK BEEKMAN said that at the joint meeting of the New York Surgical Society and the Philadelphia Academy of Surgery in Philadelphia in 1926, Dr. DeForest Willard presented a boy who had sustained a supracondylar fracture of his humerus, the lower fragment being displaced posteriorly and upward. Union had occurred without the deformity being corrected, a new shaft of the lower fourth of the humerus being formed within the periosteal tube which had been stripped off the lower end of the upper fragment and later, this portion of the original shaft had become absorbed, so that at the time the patient was presented, there was no deformity or interference with the function of the elbow.

The patient whom Doctor Beekman presented showed a similar condition. He was a boy who, at the time of the accident, May 7, 1927, was ten years of age. He had fallen, striking his left elbow upon the sidewalk, and

sustained a supracondylar fracture of the left humerus. The fracture line was transverse and the lower fragment was displaced backward and upward. (Fig. 10.) Because of the swelling of the soft tissue, immediate reduction and immobilization was thought to be inadvisable and the limb was suspended by adhesive straps applied to the forearm. Later, it was found impossible to fix the lower fragments.

In three weeks' time, it was noted that both flexion and extension at the elbow joint were much limited and that supination and pronation of the forearm were normal.

A röntgenogram of the elbow, secured four weeks after the accident, showed new bone formation in the periosteal tube. (Fig. 11.)

Two months following the injury, full flexion was limited to ninety degrees and extension to one hundred and fifty degrees and the X-ray showed that the old shaft blocked further flexion of the elbow by impinging upon the coronoid process of the ulna. (Fig. 12.) A year later the elbow had motion of eighty degrees flexion and extension less ten degrees of the normal.

FIG. 12. FIG. 13.

FIG. 12.—Same as view in Fig. 2, six weeks following the injury. End of upper fragment is becoming rounded off by absorption of the bone.

FIG. 13.—Two years following injury. Flexion not obstructed. End of upper fragment which formed bony block absorbed.

At this date the function is found to have increased, so that extension is normal in range and flexion is but slightly limited, the forearm being carried to a position forming an angle of thirty-five degrees with the arm. There is no anatomical deformity and the X-ray shows that the bony block caused by the distal end of the upper fragment has disappeared, that portion of the original shaft having been absorbed. (Fig. 13.) Thus, a year passed before the bone producing the block commenced to absorb.

Fractures about the elbow joint in adults, in which complete reduction has not been obtained will invariably produce functional disturbances, but not so in the child. It is surprising to observe the results of injuries of the lower end of the humerus, in which it has been impossible to obtain a satisfactory reduction, as the majority of these patients attain normal function.

This case is presented as a plea for conservative treatment in caring for fractures about the elbow in children. The writer has seen patients with less deformity operated upon and in one instance, osteomyelitis followed an infection of the wound producing a marked limitation of motion in the joint. In the growing individual, nature tends to overcome deformities, consequently, we must bear this in mind and treat such cases conservatively.

DR. CHARLES E. FARR considered this to be an excellent result. He agreed with Doctor Beekman that it was wiser to leave these cases alone as

a rule; but occasionally this policy was followed in later years by very bad results and he wondered if there were special indications when to and when not to interfere.

DOCTOR BEEKMAN rejoined that it was common to see adults with deformity resulting from fracture in childhood but it was difficult to disclose the type of intercondylar fracture they had had. The speaker had a patient with a fracture of the elbow in which the fragments had been displaced respectively, laterally and mesially. The child now has a deformity although there is full motion.

ENTEROGENOUS CYST OF ASCENDING COLON

DR. FENWICK BEEKMAN presented a girl who had been admitted to the Children's Surgical Service of Bellevue Hospital November 15, 1927. She was five and a half years of age. She had always been well until the twenty-four hours before admission to the hospital when she was suddenly taken ill, complaining of a cramp-like pain which centered in the right lower quadrant of the abdomen, she could not sleep and she vomited several times. These symptoms continued until the time of admission to the ward. Her bowels had moved the day before and during the morning of the day of admission. She had passed no mucus or blood by rectum. She described the pain as being around and to the right of the umbilicus. Her temperature was one hundred and six-tenths and pulse one hundred and thirty-four. The leucocyte count was eleven thousand with a differential count of seventy per cent. polymorphonuclear leucocytes.

The abdomen, on examination, was found to be soft, the anterior wall retracted and there was no tenderness to palpation. Active waves of peristalsis could be seen and on palpation, a freely movable, slightly tender, sausage-shaped mass was felt in the right lower quadrant. This appeared to be the size of a hen's egg and moved with the respiratory movements. During the twenty-four hours that the patient was observed, while in the hospital, her condition did not change. There was no further vomiting and the bowels moved again after an enema had been given.

The pre-operative diagnosis was a partial intestinal obstruction, the probabilities of it being an intussusception. The patient was operated upon twenty-four hours after admission, under ether anæsthesia. The abdomen was opened by a three-inch incision through the right rectus muscle at the level of the umbilicus. The terminal ileum was found slightly distended and a mass about three to four centimetres in diameter was found situated in the angle between the terminal ileum and the ascending colon. It was so placed that it pressed upon the wall of the ileum just proximal to the ileocæcal valve. It was round, freely movable and covered with healthy looking peritoneum. On palpation, it gave the sense of containing fluid. It appeared to be situated in the mesial wall of the ascending colon. The peritoneum over this mass was incised and an attempt was made to enucleate it. In doing this the cyst ruptured, the contents being a thick, glairy mucus of a slightly yellow color. The lining of the cyst was apparently normal intestinal mucous membrane which contained no folds. Except for the mucous membrane and the serosa, there were no other layers to the wall of the cyst. As the condition of the patient was not particularly good, the edges of the wall of the cyst were sutured to the edges of the parietal peritoneum. Just as this procedure was finished, the child commenced to strain violently under its anæsthetic and a

small amount of fæcal material was forced from the colon through a small opening into the cyst.

Two days following the operation, the wound was dressed and fæcal material was found coming from the wound. A fæcal fistula became established which failed to close spontaneously.

June 15, 1928, seven months after admission, the child was again anæsthetized and an elliptical incision was made about the mouth of the fistula and the skin edges of this flap were closed over it. The abdomen was entered just mesial to the tract of the fistula. The intestinal wall was clamped proximal to the opening of the fistula and the tract was divided with a cautery. The opening in the gut was closed with two rows of sutures, its edges being invaginated. The abdominal wall was closed about a cigarette drain. The child made an uneventful recovery and was discharged from the hospital August 9, 1928, and since then has been well.

Doctor Beekman remarked that enterogenous cysts arise in a similar manner to congenital diverticulæ of the intestines. A few may be due to the obstruction of the opening into the intestine of a congenital diverticulum; a retention cyst. Enterogenous cysts and congenital diverticulæ result from the growth of a prolongation of the lining epithelium of the intestine, in the embryo, into the mesenchyme, where it becomes vacuolated. If this prolongation of cells into the mesenchyme remains connected to the lining epithelium of the intestines, a diverticulum is formed. If the group of cells becomes isolated in the mesenchyme, they produce a cyst. Enterogenous cysts may lie beneath the mucosa, the serosa or even isolated between layers of the mesentery. These cysts contain elements of the intestine, whether they lie in its wall or free in the mesentery and should be differentiated from those due to other causes, as the ones developing from the Wolffian body and dermoid, parasitic and malignant cysts.

The wall of an enterogenous cyst always consists of mucosa and may or may not have a muscular or serous layer. Its contents are due to the secretion from the cells and are of a mucilaginous character.

Congenital diverticulæ and enterogenous cysts may be situated at any point in the intestinal tract. Diverticulæ are particularly common in the upper portion, especially the duodenum. The cysts are more often situated about the cæcum and proximal part of the ascending colon.

Clinically, the cyst is often first discovered by producing symptoms of intestinal obstruction due to mechanical pressure, a volvulus or intussusception. Occasionally they grow to enormous size.

An article on this subject with an exhaustive study of the literature has recently been published in the British Journal of Surgery (vol. xvii, 1929) by Arthur Evans, of Westminster Hospital, London.

ACUTE PERFORATED ULCERS OF THE STOMACH AND DUODENUM

Dr. Paul Dineen read a paper with the above title for which see page 1027.

Dr. John A. McCreery said that his experiences at Bellevue Hospital had very closely paralleled the results shown by Doctor Dineen. He appre-

ciated particularly the emphasis that was placed on the value of the follow-up, not only with regard to the physical condition, but also the mental and moral examination which Doctor Dineen summed up in the word "coaching." Alcohol had been more of a factor in the cases coming to Bellevue than in those presented, many of the Bellevue cases giving a history of a few days to a week prolonged alcoholic excess immediately preceding the perforation. In about 10 per cent. of the cases the perforation came out of a clear sky as the first symptom of ulcer, the remaining cases having histories suggestive of ulcer varying in duration from weeks to years.

As regards procedure, without question the first and most important is immediate operation and closure of the perforation, but Doctor McCreery did not agree that nothing more should be done in any case, as it seemed to him that if one felt that gastro-enterostomy should be done for the cure of duodenal ulcer there were certain cases of perforated ulcer in which it was indicated. These seemed to him to be the cases in which there was a more or less extensive area of induration about the perforation, suggesting that a considerable amount of diseased tissue was still present, while in other cases in which one found an apparently normal duodenal wall about the perforation—in other words, complete destruction of the disease by the accident—closure alone was all that was necessary. Operative obstruction is rarely a reason for gastro-enterostomy as this type of obstruction usually disappears very rapidly. On the First Division at Bellevue Hospital 30 per cent. of the cases of perforated duodenal ulcer had an immediate gastro-enterostomy done, as opposed to 10 per cent. of the gastric ulcers. In the latter it was done because of the feeling of the operator that there had been interference with the lumen of the intestine. Following these indications, secondary operation had been necessary in only four cases. In one a gastro-enterostomy was done for recurrence of a duodenal ulcer after eight months. In three a partial gastrectomy was done for recurrence of a gastric ulcer.

Recent foreign literature has emphasized the possibility or advisability of resection in these cases. Doctor McCreery felt that indications for such a procedure with a contaminated peritoneum were very rare. One such operation had been done on his service in a case in which satisfactory closure of a large perforation had been impossible because of extensive induration. The result had been satisfactory but the procedure should, with very rare exceptions, be condemned.

Dr. Richard Lewisohn remarked that Doctor Dineen had said that many patients needed to observe a strict diet over a long period. It is fair to assume that a number of such patients are still suffering from a chronic ulcer. The opinion that perforation cures an ulcer in practically every case is certainly erroneous. One of the methods of treating chronic duodenal ulcer by cautery-puncture is based on this idea. It is very evident that a great many cases with ulceration of the wall of the duodenum cannot really be cured by an acute perforation, for in many cases one is dealing with a

double ulcer, one in the anterior and one in the posterior wall of the duodenum. The ulcer on the anterior wall perforates and is closed by suture; the ulcer on the posterior wall, however, continues to give symptoms.

The statistics of acute perforated ulcers, operated on during the years 1915 to 1925 at Mount Sinai Hospital, have been published by Doctor Stenbuck. Doctor Lewisohn stated that he had seen these patients in 1927 in order to find out how many of the cases were perfectly well. On re-examination, which was done very carefully by questioning the patient, giving test meals, taking X-rays, etc., it was found that a great many of them had symptoms of persistent ulcer. X-rays showed retention pockets in the duodenum and tenderness on pressure, proving that the ulcerative process was still going on. Doctor Dineen had mentioned pyloric spasm which he attributed to nervous upsets. On careful examination, this symptom might be found to be due to a persistent ulcer.

Referring to Doctor Dineen's report of twenty per cent. of absolute failures or incomplete cures, Doctor Lewisohn said that in the Mount Sinai statistics, there were thirty-nine per cent. failures. That leads to the question whether one should not attempt more radical work at the time of operation. In Germany and Austria surgeons performed partial gastrectomy as the primary operation, but the speaker believed that in the acute stage these cases should not be subjected to any radical procedure. He believed it wiser to do as little as possible, during the acute stage, and observe the patients carefully for six months Then, if ulcer symptoms were still present or if they suffered from seasonal attacks, these patients should be subjected to partial or sub-total gastrectomy. The speaker stated that unquestionably many of these patients are not permanently cured, and that the acute perforation failed to cure the ulcer in a large number of cases.

Dr. J. William Hinton asked Doctor Dineen whether he distinguished between gastric and duodenal ulcer. He was in agreement as to simple closure giving good results. In the Gastro-Intestinal Clinic at Bellevue Hospital 201 cases of ulcers were under observation. In that group 164 were duodenal, twenty-seven with acute perforation; of these, seventeen had simple closure, seven pyloroplasty of the Horsley type, and three had closure plus gastro-enterostomy. It is interesting to note that of the duodenal ulcer group, five perforated while under medical treatment in the clinic; four of these cases never had surgery performed; and one had had an acute perforation and recurrence of symptoms. In this series thirteen were diagnosed by the operating surgeon as perforated gastric ulcer. Of that group nine have been re-X-rayed and all had definite duodenal lesions; none had any evidence of gastric lesions. Two were too recent to re-examine and two failed to return for X-ray examination. In following these nine cases it was found that four needed subsequent surgery, three for scar tissue obstruction of the pylorus; one patient had gone five and one-half years following the first operation, and the shortest case, ten months.

Doctor Dineen had stressed the fact that these patients have symptoms if not properly followed and in the Bellevue group there were five cases that had been operated on in other hospitals in this city, one case having been symptom-free for fifteen years before returning for treatment; the other cases ten, seven, six and five years.

DR. CHARLES E. FARR reported the data for perforated gastric and duodenal ulcers from the First Surgical or Cornell Division of the New York Hospital, service of Doctor Gibson.

Total number of cases was 139 of which eighty were duodenal and fifty-nine were gastric. One hundred and thirty-three were males; six were females.

The total operative mortality was 17.9 per cent.

The number of cases within the twelve-hour period was 110, and within the eighteen-hour-period, five. In this series there were fourteen deaths or 12.1 per cent. mortality.

In the next six-hour period, from eighteen to twenty-four hours, there were nine cases with two deaths or 22.2 per cent. mortality. All cases over twenty-four hours in duration numbered fifteen, with nine deaths, the mortality being 60 per cent.

It is interesting to note how closely these figures resemble those given by Doctor Dineen. This makes a total number of cases from the New York Hospital of 281 giving a mortality percentage of almost exactly 20 per cent.

Their treatment of these cases is very closely similar to that of Doctor Dineen's and the end-results closely approximate his. They are possibly a little more opposed to primary gastro-enterostomy:—First, because it is exceedingly difficult to be sure that the gastro-enterostomy is needed. Second, because there is a definite mortality for gastro-enterostomies in the hands of even the most expert surgeon. Third, the results of gastro-enterostomies are not 100 per cent. good. They, therefore, feel that a gastro-enterostomy is scarcely ever indicated in acute perforations. The degree of occlusion of the pylorus must be judged by its condition before the closing sutures are placed, not afterward. It is very improbable that a closure by sutures will persist. We all know how extremely difficult it is to close the pylorus by operative procedure.

DR. ROBERT T. MORRIS emphasized two points, one practical and the other theoretical. Nothing was said in the paper about patients in shock or bad condition when first seen. In those cases one should not stop even for simple suture but make immediate incision, put in a drain, do nothing more and discover how surprisingly many will recover from a ten-minute operation particularly if this is followed by the Ochsner starvation treatment. As to the theoretical point, it was a source of wonder to Doctor Morris that Rosenow's theory of elective affinity for toxins was not held in greater respect. It gives a working theory for duodenal and gastric ulcers. If there is toxic blocking of any terminal artery the circulation is shut off. That

area representing the terminal artery is then exposed to bacterial and digestive processes. There may be overaction of antibodies. With that in mind, why may one not have a clear enough picture of the etiology of duodenal and gastric ulcer? There is little mystery above their occurrence so far as Doctor Morris looked at the matter.

Dr. Ralph Colp reported thirty-four cases of perforated duodenal ulcers from the surgical service of the Beekman Street Hospital. Two-thirds of these were gastric in origin, and one-third duodenal, and all occurred in males.

The patients were operated as soon as possible after admission and the surgical procedure in all was that of simple closure of the perforation. It was felt quite strongly that this was all that was necessary inasmuch as the chances of narrowing either the duodenum or pylorus to such a degree that an acute obstruction would result, was almost impossible, and even if this untoward complication should occur, gastro-enterostomy could always be done within twenty-four hours. In addition, it has been shown that gastro-enterostomy is often accompanied by subsequent gastro-jejunal ulceration, some clinics reporting this complication as high as 33 per cent.

Intra-peritoneal drainage was never employed, and in a few selected cases a piece of rubber dam was placed down to the peritoneum to take care of possible abdominal wall infection.

While a great majority of these cases were done within an eight-hour period, there were several which were operated as late as twenty-four hours after perforation.

In this series of thirty-four cases, there were two deaths, making a mortality of 6 per cent. One of these patients died from a spreading peritonitis, and the other, although operated under spinal anæsthesia, died within twenty-four hours from an acute collapse of the lung.

Doctor Dineen, in closing the discussion, said that his paper represented the experience of the men on the Second Surgical Division of the New York Hospital. He knew that many excellent surgeons were doing gastro-enterostomies and publishing splendid results. He considered that Doctor McCreery had summed up the subject very well and his indications would cover almost any case. As to Doctor Colp's remarks, Doctor Dineen felt that his mortality of 6 per cent. was remarkable. As to the question of drainage, he drained through the peritoneum where there was an excessive amount of fluid, but ordinarily drainage was done down to the peritoneum. As to Doctor Morris' point regarding shock, most of these patients when admitted are suffering with an acute peritonitis and naturally the treatment of shock must be considered. His own impression was that in these acute perforations the initial condition is not what is generally thought of as shock. It is rather an acute inhibition. Regarding the theoretical point, Rosenow's theory is a very important one and has received much consideration but as to the exact etiology the speaker knew nothing. Regarding Doctor Hinton's observations as to the difference between duodenal and gastric ulcers, Doctor

Dineen said he had tried to make this differentiation in a previous study. Most of the perforations took place in or about the pyloric vein but with the acute inflammatory reaction it was hard to say which side it was on. About four of the duodenal ulcers to one of the gastric had been the approximate observations As to recurrence of symptoms, it was questionable if anyone was ever really cured of gastric or duodenal ulcer; it was probable that they need always to be under treatment. Regarding Doctor Lewisohn's suggestion as to the gastric symptoms lasting a long time, and the question of diet, Doctor Dineen believed these patients must always be kept under observation. He remembered a case of Dr. Charles Peck, free from symptoms for eighteen years and then re-operated. As to the follow-up of these cases they do have definite spasm which disappears a little later. As to whether this is pyloric spasm or a nervous symptom is not known; they have been offered surgery but have refused. As to resection Doctor Dineen had no experience. Dr. McCreery's remarks were very interesting and Doctor Dineen believed that duodenal ulcer with excessive obstruction of the pylorus was an indication for gastro-enterostomy. Regarding Doctor McCreery's observations on the relation of alcohol to these perforations, Doctor Dineen's experience had been the exact opposite inasmuch as few of his cases of perforated ulcer gave an alcoholic history.

BRIEF COMMUNICATIONS

TRAUMATIC ANEURISM OF THE SUBCLAVIAN ARTERY

WITH COMPLETE BRACHIAL PLEXUS PARALYSIS

THE following case is of interest because of the comparative rarity of traumatic aneurism of the subclavian artery and the subsequent pressure paralysis of the brachial plexus.

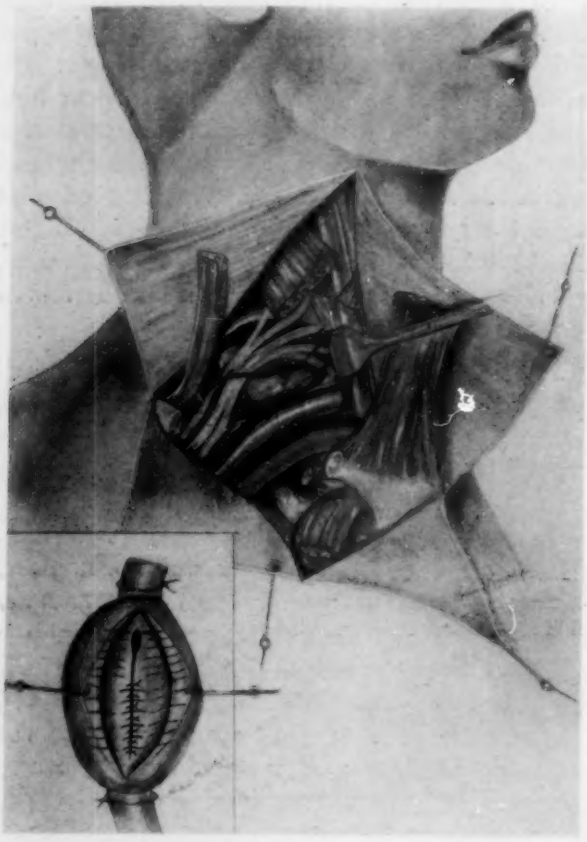

FIG. 1.—Drawing showing the aneurism in the second portion of the subclavian artery. The nerves of the brachial plexus are shown stretched across the sac. Exposure was obtained by removal of the clavicle and division of the sternomastoid and omohyoid muscles. Insert shows method of obliteration of the aneurism.

J. S., a negro boy of eighteen, was first seen April 15, 1924. His complaint at that time was inability to use his right arm and hand. Two weeks previously he had been stabbed in the right side of his neck with a knife. The wound, which was 2 cm. long, was located just above the middle of the clavicle. At the time of the injury the wound bled profusely, but the hæmorrhage was controlled by pressure and by suturing the skin. Twenty-four hours later a numbness was noticed in the hand, and in forty-eight hours the arm, forearm and hand were numb and paralyzed.

Examination showed a complete sensory and motor paralysis of the whole right upper extremity, except for an area of normal sensation over the shoulder cap and an ability to partially externally rotate the arm. The wound in the neck was well healed, but directly beneath it an expansible tumor about 3 cm. in diameter could be felt. A distinct systolic thrill and bruit could be detected over the tumor. The blood pressure in the two arms was the same; systolic 115, diastolic 85.

It was believed that an aneurism of the subclavian artery was present and that the paralysis of the upper extremity was due to pressure, since the latter did not appear until twenty-four hours after the injury and was progressive rather than abrupt, as would have occurred in case the nerves of the plexus were severed.

Operation was performed under ether anæsthesia May 6, 1924, five weeks after the injury. An incision was made over the clavicle and the middle three-fourths of it removed. Another incision was made upward from the clavicle along the posterior border of the sternomastoid muscle. Skin flaps were raised and the deep fascia of the neck incised. The subclavian artery and vein were identified and the aneurism was found arising from the artery at the outer border of the anterior scalene muscle.

FIG. 2a and b.—The patient two years after operation, showing normal muscular development of the right extremity and normal movements.

The three trunks of the brachial plexus, which were stretched tightly across the aneurism, were dissected free from it. The anterior scalene muscle was retracted medially in order to reach the second portion of the subclavian artery, which was then ligated with heavy braided silk. The artery was ligated distal to the aneurism in the same manner. The sac was opened and the wound in the artery, about 1.5 cm. long, disclosed. An obliterative aneurismorrhaphy was then done with interrupted sutures of fine silk. The transverse cervical and transverse scapular arteries were encountered as they ran across the brachial plexus and care was taken not to injure them since the main anastomotic circulation was carried through them. The trunks of the brachial plexus, which were held away from the operative field, were replaced and the wound closed without drainage.

FIG. 2b.

Following the operation, there was an obliteration of the brachial and radial pulse, but the arm and hand remained warm and well nourished. Within two weeks there was a return of sensation over the thumb and radial side of

the arm and hand, and in three weeks sensation throughout the extremity was practically normal. In four weeks, motion returned in the biceps, followed shortly by motion in the triceps and extensors and flexors of the wrist and fingers. Motion returned last to the lumbrical and interosseous muscles, but within a year all motion was normal. The loss of a greater portion of the clavicle caused no disabilit either in motion or strength.

Comment.—Complete sensory and motor paralysis of the upper extremity due to pressure of traumatic aneurism of the carotid artery is unusual and following injury is usually incorrectly diagnosed as a primary nerve lesion. In this case the onset of the paralysis, twenty-four hours after injury, indicated that nerve lesion was due to pressure rather than actual interruption. Sensation was interfered with first and was the first to return after release of pressure. The lower trunk of the plexus was first affected, and since subjected to the most trauma by reason of its position, was the last to return. Removal of the greater portion of the clavicle had no appreciable effect on either motion or strength of the extremity.

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TRAUMATIC RUPTURE OF HYDRONEPHROTIC KIDNEY

IN 1927 Herman[1] reported a case of "Ruptured Hydronephrosis." He demonstrated a rent in a hydronephrotic sac by urography, and considered his the only instance of preoperative urological diagnosis of this condition. Because of its rarity and interest the following case is published.

R. M., age eighteen, was referred by Dr. Bruce Brockway, of Toledo, Ohio, with the following history. About four o'clock on the afternoon of February 2, while coasting, the patient fell from a sled and struck his left side against a concrete block. He was taken to his home in a semi-dazed condition. He complained of severe pain in the upper left portion of his abdomen. About an hour later he urinated bright red blood. He was immediately taken to The Flower Hospital. His past medical history was negative except for the usual diseases of childhood, including scarlet fever, and the fact that as long as he could remember he would have occasional attacks of slight pain in the left portion of his abdomen. Examination of his urine was always reported to be negative, with the exception of one instance five years ago when albumin was found, and he had had no urinary symptoms. His family history was negative.

Examination at the hospital revealed the following. The patient was a young boy apparently in some shock. The mucous membranes were blanched, the lungs normal to auscultation and percussion, the heart sounds normal. The pulse was 80, blood pressure 100 systolic, 80 diastolic. There was some rigidity and tenderness of the upper left portion of the abdomen, also tenderness in the left costo-vertebral angle. There was a suggestion of a mass in the left lumbar region. It was impossible to determine the presence of fluid in the abdomen. The liver and spleen were not palpable. The external genitalia were normal. A small catheter was passed into the bladder and almost pure blood obtained. Because of this it was thought best to cystoscope the patient.

At 8 P.M. of the day of the injury a small size cystoscope was passed easily into the bladder. The bladder wall appeared normal throughout. The right ureteral opening was normal, and clear spurts of urine were seen to issue from it. The left ureteral opening

was very small, and several bloody spurts appeared from it. A small catheter was passed up the left ureter without difficulty. From this very bloody urine was obtained. Fifteen c.c. of a 12 per cent. sodium iodide were injected gently into the catheter. The resulting pyelogram had the following appearance: The ureteral catheter made a direct turn back upon itself in the lower portion of the ureter. The ureter throughout was markedly widened and tortuous. The lower calyx was partially filled and there was considerable amount of the iodide solution extravasating about the kidney.

Following cystoscopy the patient seemed to be in good condition. Four hours later he was reacting nicely from shock. On the following day he was quite comfortable, and his pulse was good. Examination of the blood at this time showed the hemoglobin to be 55 per cent., red blood count 2,850,000, white blood count 15,300, with 87 per cent. polymorphonuclear leucocytes, and blood urea nitrogen 17 mg. for 100 c.c. of blood. The urine obtained from the left kidney showed very many red blood cells, five to ten white blood cells per high power field, and a culture showed no growth. The following afternoon the patient developed severe pain in the left side of the abdomen. Dullness could be elicited in the left flank, which was not movable on tilting the abdomen. A tender mass could be palpated in the left iliac fossa, and there was an increase in the tenderness of the perirenal space. There was no acceleration of the pulse rate, nor drop in the blood pressure.

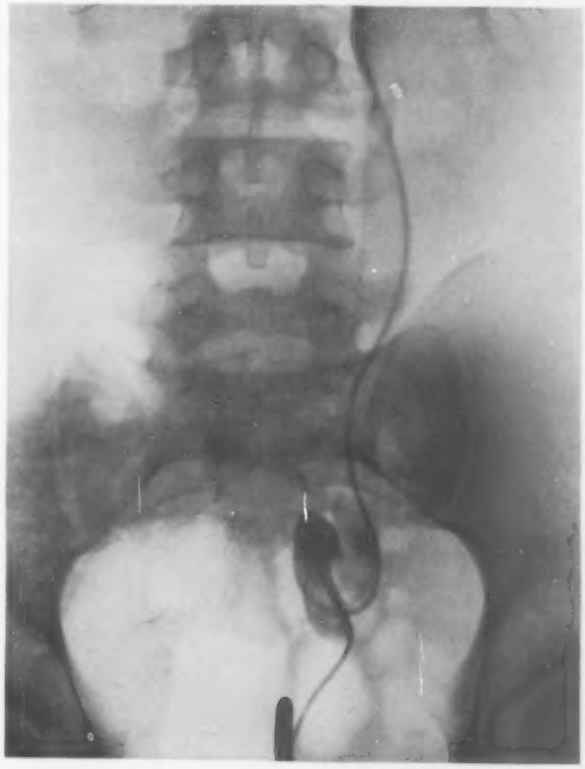

FIG. 1.—Urogram of left kidney and ureter.

It was considered at this time that the patient was suffering with a recurrence of the bleeding, with an extension of the blood downward behind the peritoneum towards the pelvis. A diagnosis of rupture of an old hydronephrotic kidney, with hæmorrhage and extravasation of urine, was made, and operation performed immediately. Under gas oxygen anæsthesia a large left kidney incision was made according to the method of W. J. Mayo, exposing the perirenal capsule. All of the tissues were œdematous. The fatty capsule was incised and a large amount of blood gushed into the wound. The renal pedicle was secured with the left hand after fracturing the twelfth rib, and a large pedicle clamp applied. The kidney was then seen to be markedly enlarged, and severely lacerated through its mid portion. The pedicle was then severed and the kidney removed. Three cigarette drains and a strip of iodoform gauze were used for drainage. The wound was closed with running sutures of catgut. The patient left the operating room in fair condition. The pedicle clamp was loosened on the fourth day and removed on the fifth.

The pathological report was as follows: Specimen consists of several large pieces,

the total weight being 430 gms. Cut surface presents an honey-comb appearance, there being several large cysts surrounded by very thick fibrous tissue. There are quite a few hæmorrhagic areas. The cysts contain, in addition to pus, some more or less necrotic kidney tissue. Pathological diagnosis: Old hydronephrosis with fibrosis and degeneration of parenchyma. Traumatic rupture of kidney. Pyonephrosis.

On the day following operation the patient's condition was good, temperature 100, pulse 90, respiration 18, with urine containing albumen, but negative for pus or blood. All drainage was removed by the tenth day. February 16, 1929, the hemoglobin was 52 per cent., red blood count 2,670,000. There was an afternoon rise of temperature to about 101. Drainage from the wound was sero-sanguinus. By March 16, 1929, the wound was almost healed, and the patient was walking about and feeling much stronger. The hemoglobin was 60 per cent., red blood count 3,040,000, blood urea nitrogen 14 mg. per 100 c.c. The patient was discharged from the hospital. On August 20, 1929, he felt well, and had no urinary symptoms. He was able to carry out his usual work without fatigue. His weight was 150 pounds (weight before injury, 148 pounds). The urine examination was negative except for an occasional white blood cell. The blood urea nitrogen was 12 mg. per 100 c.c. of blood.

The advisability of urography in rupture of the kidney or ureter is questionable. In this instance no harm could be traced to it, and the pathological condition was ascertained before operation. If the rupture was known to extend into the peritoneum, urography would seem to be contra indicated.

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[1] Herman, Leon: A Case of Ruptured Hydronephrosis. The Journal of Urology, November, 1927, pp. 458–470.

A SUBCUTANEOUS FASCIAL STRIPPER

In recent years living fascia has been used increasingly in a variety of operations. Several years ago the writer was told that fascial strips for use in hernial repair could be obtained by means of the Mayo stripper. Efforts made with this instrument resulted so unsatisfactorily that it was determined to make a special instrument somewhat on this principle which would give adequate strips for use in any desired surgical procedure. On this account a fascial stripper was made that has been used by various surgeons on different services of Bellevue Hospital with satisfactory results. The instrument is made with a long handle like a vein stripper. The lumen is, however, rectangular. The edges of the lumen are sharp, except the posterior one. The strippers are made with different size lumena. The smallest size will cut adequate strips for the fascial repair of any hernia. The medium size will cut a strip which can be divided longitudinally into about three strips of requisite width as a rule. The measurements of the strippers are as follows:

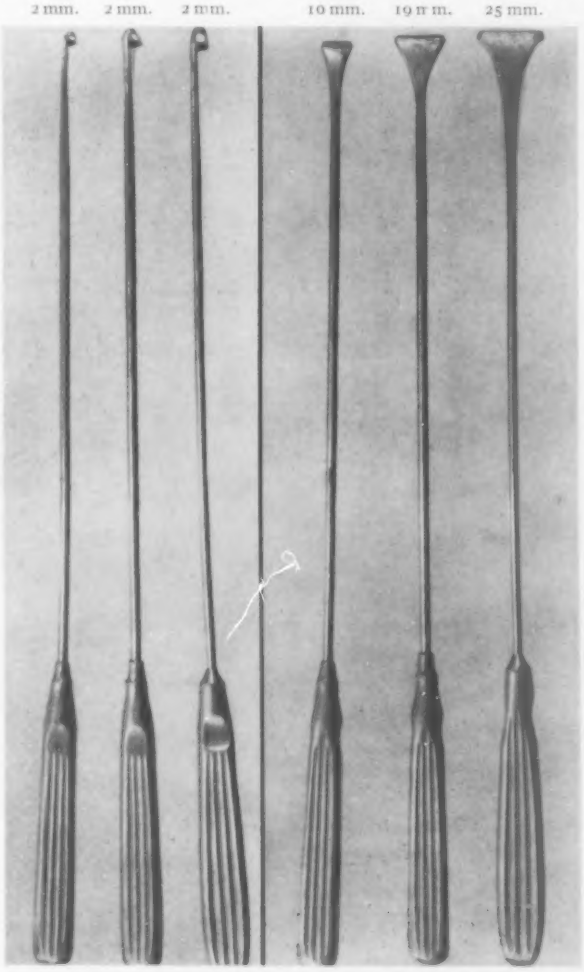

Fig. 1.—The illustration shows three different sized strippers.

Over length	14½ inches
Length not including handle	9¾ inches
Size of openings	
Small	2 x 10 mm.
Medium	2 x 19 mm.
Large	2 x 25 mm.

The width of 2 mm. is just sufficient to accommodate the thickness of the fascia lata.

The method used by us has been as follows: A small transverse incision is made on the outer femoral region just above the line of the knee-joint and the ilio-tibial band is exposed. Its outer and inner surfaces are cleaned of attached tissue and, with a knife, strips of 10 mm. or 19 mm. wide are started if either the small or medium strippers are used. These strips are dissected for about 3 or 4 cm. of their length and are then threaded through the appropriately sized stripper. A Kocker clamp is used to hold these threaded ends and the stripper is pushed upward along the outer thigh for the required length. A longitudinal small counter incision is made down to the fascia and after it is severed transversely it can be drawn by the Kocker clamp through the lower wound. Any number of strips can be obtained in this way. The advantages of this method are obvious.

It makes it possible to do away entirely with the surgical assistant employed in the older method of obtaining these strips. It makes the procedure relatively minor. It cuts down the operating time. It gives the patient two small scars, a lower transverse and an upper longitudinal instead of the usual long unsightly scar. It reduces the possibilities of infection because of the above factors.

The instruments are made by George Tiemann & Company, New York, N. Y.

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CARCINOMA OF THE APPENDIX*

CARCINOMA of the appendix is not a great rarity; but it is a condition that occurs with such relative infrequency, that one is warranted in reporting a case. The incidence of occurrence is varyingly stated, but the average of several statistics studied is 0.39 per cent. of all appendices removed. It is usually an accidental pathological finding and is removed in the course of a laparotomy performed for some other reason.

The cases reported in this paper show atypical clinical pictures of appendicitis and a differential diagnosis was quite difficult.

CASE I.—C. F., white, female, single, age twenty-three years, was admitted to the New York Post Graduate Hospital March 13, 1929. Her chief complaint was indigestion, characterized by: nausea, but no vomiting, and pain in the abdomen localizing. Latterly the attacks have occurred with greater frequency and intensity. There has been some dysuria, but no hematuria.

Her temperature was 99. Pulse—90. She was thin and poorly developed. The only noteworthy fact was some tenderness low down in the right lower quadrant, below McBurney's point. There was no hernia. Some right kidney tenderness. No vaginal examination. Rectal examination negative.

* From the Surgical Service of Dr. Charles Gordon Heyd, New York Post Graduate Medical School and Hospital.

An X-ray showed at the level of the lumbo-sacro joint about 6 cm. to the right of the median line a shadow 1½ cm. in its long diameter, and 1 cm. in width, of rough and irregular appearance. The absence in the history of hematuria or renal colic caused the shadow to be construed as that of a calcified lymph node, and not ureteral calculus.

Operation.—(by Dr. Moolten) March 15, 1929.

The abdomen was entered through a right paramedian incision. The appendix was congested, tumefied, and wrapped in omentum. The adhesions separated easily, indicating a recent inflammatory process. A typical appendectomy with inversion was performed, and the abdomen closed without drainage.

On section, the tip of the appendix appeared to be calcified to the extent approximately of the size of the X-ray shadow. The rest of the mucosa was thickened and necrotic.

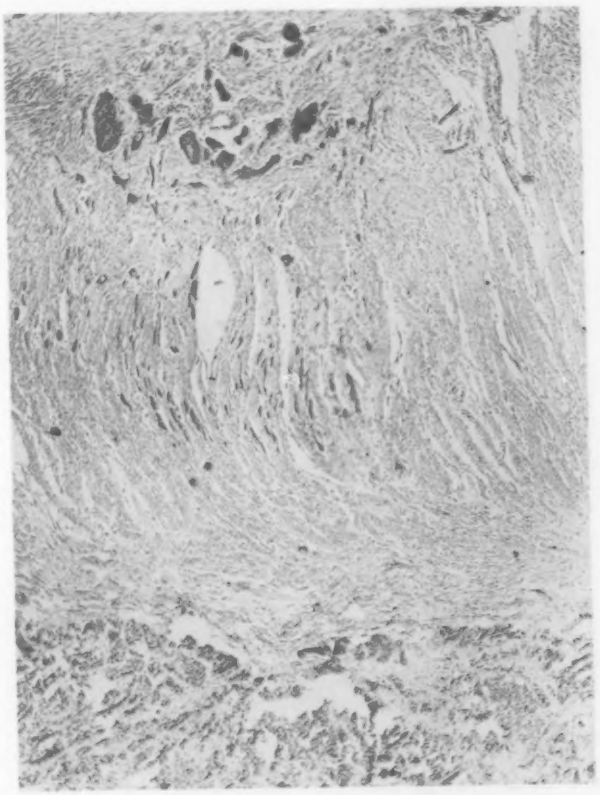

FIG. 1.—Carcinoma of appendix vermiformis. Case I.)

Report of Tissue Examination (by Dr. Nicholas N. Alter, Lab. No. 10965-38881).

Appendix measures 4 cm. in length. It has been opened and measures 2 cm. in width. The wall is greatly thickened and averages 8 to 9 cm. in thickness. The distal end consists of several yellowish gray rather firm nodules which measure from 5 to 12 cm. in diameter. The serosa contains a few fibrous tags.

Microscopic.—Section through the tip of the appendix shows the mucosa replaced by an epithelial growth which is arranged in irregular strands, some places resembling glandular tissue. There is an occasional mitotic figure seen. In one place a few strands of epithelial growth are seen in the muscular tissue but in most parts of the section the growth seems to be limited by the musclaris muscosa.

Sections from the lower portion of the appendix show some remaining mucous membrane which is lined by high columnar epithelium, but there are numerous old ulcerated areas which are partially covered by regenerated epithelium. Beneath this, some old granulation tissue can be seen and in areas there is rather rich infiltration with lymphocytes and plasm cells. The submucosa is greatly thickened and fibrotic. The inflammatory infiltration extends entirely through the muscular layer and the serosa which is markedly thickened and shows rather rich inflammatory infiltrations. There are also numerous congested blood vessels in the serosa.

Diagnosis.—Carcinoid of appendix with chronic inflammatory changes.

NOTE.—This is a benign type of epithelial growth which does not tend to metastasize.

CASE II.—A thin, poorly developed white woman, married, age twenty-five years, was admitted to hospital on account of pain in right side which had been more or less constant for one year. Occasional indigestion and vaginal discharge since onset of pain. Loss of weight probably due to failing appetite. For past two weeks pain has been worse and she has not been able to work. Except for tonsillectomy five years ago, her past history is not significant. Menstruation has been regular in occurrence, but during the past year has tended to be more copious in amount, and has changed from a four to five day duration. Her temperature was 98.8. Pulse—80.

Abdominal examination revealed some tenderness over McBurney's point. Vaginal examination: Retroversion of uterus. Rather copious mucoid discharge. Smear did not reveal any Neisserian organism. Extreme tenderness in the right fornix.

FIG. 2.—Carcinoma of appendix vermiformis. (Case I.)

Operation.—(By Dr. Moolten), at the N. Y. Post Graduate Hospital, April 23, 1929. After dilatation of cervix and curettage the abdomen was entered through a low median incision. The appendix was found enmeshed in tortous adhesions causing the appendix to spiral around itself. Other adhesive bonds firmly bound both to the omentum and the fimbriated end of the tube. The tube itself was mildly congested. There was a small cyst of Morgagni. The right kidney was lightly enlarged and the gall-bladder normal to palpitation. Her cyst of Morgagni was removed. The appendix was freed from its adhesions and the adjacent fringe of omentum resected because of its fibrous attachment in the pelvis. A typical appendectomy with inversion was then done and the abdomen was closed without drainage. The tip of the appendix was noticed to be bulbous and hard.

Report of Tissue Examination.—(By Dr. Nicholas M. Alter, New York Post Graduate Hospital—Lab. No. 16825-39411.)

Appendix measures 7 cm. in length. The tip is swollen and covered with a great deal of hæmorrhage. The tip measures 12 cm. in diameter. On section of the lower third, the mucosa is lifted in thick folds and has a light yellow appearance. The wall is uniformly thickened, although the muscle layer seems to cover the growth. The serosa above it is somewhat congested. The mucosa above the polypoid growth is smooth and somewhat swollen. It is covered with some hæmorrhagic mucus.

There are no curettings with the specimen.

Microscopic.—Section of appendix shows part of the glandular lining of the appendix in transition to an epithelial growth which consists of small dark cells arranged in small

groups. They seem to extend to the muscle layer uniformly. One section, however, shows some invasion of the muscle tissue. The nests of epithelial cells are surrounded by lymphocytes. The surrounding stroma also contains numerous blood vessels and lymph vessels. In some of the nests, glandular arrangement is suggested. In other portions the cells are more elongated.

Diagnosis.—Carcinoid of appendix.

NOTE.—This is a typical case of the benign type that is also called "endothelioma."

Comment.—Carcinoma of the appendix is a distinct clinical entity. It occurs most often at the tip, and is always benign. The lack of malignancy is obvious as metastasis does not occur. In many cases, the origin has been demonstrated to be not from the epithelium at all, but from blood vessels. This would constitute, actually, a benign endothelioma.

There is another type of case in which a malignant tumor occurs at the proximal end of the appendix. This is not, strictly, a carcinoma of the appendix, but finds its origin in the cæcum or ileocecal valve. These tumors metastasize and demonstrate all the characteristics of other intestinal malignancies.

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FRACTURE OF THE CORACOID PROCESS OF THE SCAPULA

CASE REPORT.—Mrs. E. C. was referred by Dr. T. D. Bourdeaux July 24, 1929, for treatment of an injury of the left shoulder sustained twenty-four hours previously in an automobile accident. Examination revealed slight lacerations of the right leg and the injury to the left shoulder which is here described. The left arm was held firmly to the side, with the forearm flexed, by the right hand and arm. Constant pain in the shoulder had been experienced since the injury and motion of the arm in any direction caused great pain. There was some swelling of the infraclavicular, the acromial and the deltoid regions of the shoulder and pressure over the acromial and infraclavicular regions caused severe pain.

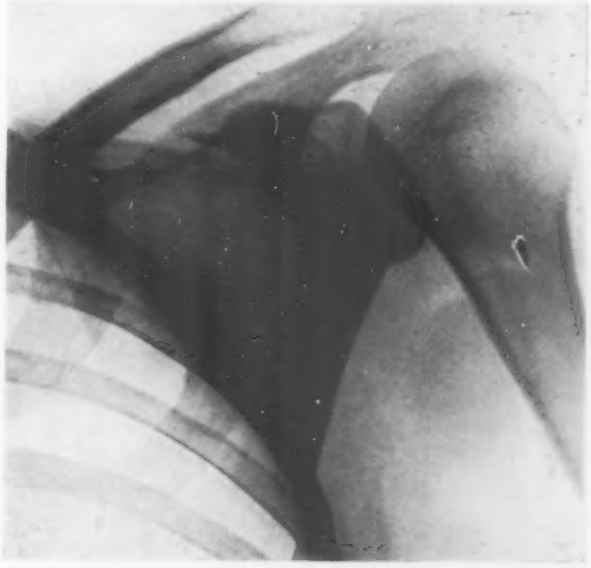

FIG. 1.—Showing deformity of the coracoid process and fracture through the base of the scapula.

X-ray of the left shoulder (Fig. 1) showed a deformity of the coracoid process of the scapula with evidence of a fracture at the base of the coracoid. The base of the coracoid was displaced upward and the tip of the coracoid pulled downward and forward.

A plaster spica was applied to the shoulder, extending to the metacarpo-phalangeal articulation, with the arm abducted and rotated inward, the forearm flexed to an

angle of ninety degrees, and the thumb pointing toward the nose. After the application of the bandage the pain in the shoulder was relieved. The plaster was allowed to remain for four weeks, at which time baking and massage was instituted and active motion encouraged. Examination at the end of six weeks showed good union with no limitation of motion in any direction.

Discussion.—Very little has been written on coracoid fractures. In a review of the literature since 1919 no articles on this subject were found. However with the increasing number of automobile and industrial accidents this fracture evidently occurs more frequently than is presently supposed and much oftener than is recorded in the literature.

Eliason mentions coracoid fractures as follows: "The coracoid has been reported broken but rarely, and then usually as a complication. Muscular action has caused it. The diagnosis is confirmed by the röntgen-ray. Treatment is best with the Velpeau bandage. . . . Fractures of the coracoid process, if uncomplicated, are very difficult to interpret. The stereoscope is indispensable here."

It is to be remembered that the tendons of origin of the short head of the biceps and the coracobrachialis are attached to the tip of the coracoid process, the actual tendon of the biceps passing deep down between the flexor and radial groups of muscles, being inserted into the tuberosity of the radius. The coracobrachialis is inserted into the anterior and internal surfaces of the humerus at about its middle, and into the internal intermuscular septum.

In view of the anatomy involved, and since in my case pain, which was an important factor, was almost immediately relieved by the immobilization in the plaster, it appears to my mind that these fractures are best treated by a plaster spica of the shoulder applied with the arm abducted and rotated inward, the forearm flexed at a ninety degree angle and the thumb pointing toward the nose.

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GAS GANGRENE OF THE ABDOMINAL WALL FOLLOWING GANGRENOUS APPENDICITIS

GAS gangrene of the abdominal wall is an extremely rare condition, and on account of its rarity and of its very serious nature a fatal case is reported in this communication.

Gas gangrene is produced clinically by several of the anaërobic organisms very often mixed with streptococci, but the Bacillus aërogenes capsulatus or Bacillus welchii is perhaps the most important. Infection of traumatic wounds by the Bacillus welchii is not rare, particularly in the agricultural districts, and of course during the World War it was not an unusual complication.

Most of the infections with the anaërobic organisms following abdominal operations are the result of the presence of the organisms in the pathologic process or due to its presence in the intestinal tract and not due to any contamination from without as are those following the traumatic cases.

It has been shown that the Bacillus welchii is quite a common inhabitant in the intestinal tract and, in fact, the organisms have been found in the blood of patients who did not show much clinical evidence of having a septicemia except for a clinical picture simulating that of pernicious anæmia.[1] Several investigators have shown the presence of the Bacillus welchii in quite a high percentage of appendiceal abscesses; Welch,[2] Flexner,[2] Wright[2] and Stokes[2] finding it in 22 per cent. of the peritoneal exudates following peritonitis which they examined. Butler[3] was unable to demonstrate the Bacillus welchii in his bacteriological studies. These included studies of appendices removed at operation, appendiceal abscesses, studies of large gut and ileum, and studies of free pus in the peritoneal cavity. Many of the cases reported as gas gangrene or emphysema of the abdominal wall were not checked by bacteriologic studies of the wounds, nor by blood cultures. Consequently, it is difficult to get, from the literature, a true picture of the frequency or course of gas gangrene produced by an anaërobic organism.

Despite the wide divergence of data it is quite apparent that the Bacillus welchii is an inhabitant of the intestinal tract in a small percentage of people and occasionally asserts itself as the cause of a pathological process. Just why this organism suddenly becomes so virulent is amazing, particularly in view of the fact of its widespread distribution. It has been recognized for a long time that it grew anaërobically on gangrenous tissue and it is logical that the gangrenous appendix offers an ideal culture medium for its growth. Acute gangrenous appendicitis is perhaps the most frequent abdominal condition following which the Bacillus welchii manifests itself in the form of gas gangrene, but gas gangrene has been reported as a complication following operations for perforated gastric and duodenal ulcers, following cholecystectomy, following enterostomy and following criminal abortion.

In reviewing the cases of gas gangrene following operations for gangrenous appendicitis, it is quite evident that there are two types of cases, one with the process a localized one, and the other one a localized infection with a general septicemia. It is hard to gather from the literature how many of the cases reported had a septicemia, as the blood cultures are not reported, but it is quite probable that the fulminating type going on to rapid death is accompanied by a blood-stream infection of the Bacillus welchii. This was true in the case reported below and in reviewing this case it is quite evident that the man had a blood-stream infection from the beginning of his illness.

If the condition is localized in the abdominal wall the treatment consists of wide and multiple incisions over the site of the involved region, combined with the administration of Bull's serum, but in the fulminating type, such as reported below, apparently any method of treatment is futile. This patient showed evidence of a profound toxemia from the very first and the subcutaneous œdema first appeared in the axilla, both of which were evidence of a blood-stream infection, or, at least, of a generalized infection.

It should be emphasized that gas gangrene of the abdominal wall does respond to wide incision and drainage in enough cases to warrant this radical

procedure, provided of course the patient's general condition will permit of the treatment. The extent of the infection is the determining factor in the prognosis. Ochsner [4] reports a case which responded to wide incisions of the abdominal wall and treatment of the open wound with Dakin's solution. Butler [3] reports two cases, one recovering after wide drainage of the abdominal wall, and the other terminating fatally in ninety-six hours. Baldwin and Gilmons [5] in 1927 collected eleven case reports of gas gangrene following gangrenous appendicitis, but the mortality of these cases is not given.

CASE REPORT.—The patient, a man sixty-one years of age, was seen at 10 P.M. June 29, 1929, in consultation with Doctor Savage. At this time the following history was obtained. The patient, an office man by occupation, had enjoyed fairly good health except for several attacks of dizziness and headache which were attributed to high blood pressure. He had had repeated attacks of right-sided abdominal pain which had been diagnosed as renal colic.

Present Illness.—The present illness began twelve hours before patient was seen by me, at which time he was seized with a severe abdominal pain, mostly in the right lower quadrant and in the right back. This was accompanied by nausea and vomiting. There had been moderate constipation prior to this attack. The patient was seen shortly after the onset of the illness by Doctor Savage, who on examination found the patient's pulse and temperature normal, with some abdominal tenderness but the tenderness was chiefly in the right flank. Eight hours after the onset of the attack the temperature was 101° and the pulse 100, and the pain was worse in the right flank. The nausea had persisted. At this time a urine examination showed the urine negative except for a slight amount of albumin, and the white blood count was 16,000. The patient was then sent to the hospital, at which time I saw him and the following was noted.

Physical Examination.—The patient was a rather obese and plethoric man. Temperature 101.5°, pulse 100, blood pressure 160/80. The general physical examination was essentially negative except for moderate cyanosis. The abdomen was distended and there was extreme tenderness on pressure accompanied by muscle spasm over the right lower quadrant and right flank. No masses were made out. Peristalsis was diminished but present to some extent. The diagnosis of acute appendicitis with which the patient was sent to the hospital was confirmed and immediate operation advised and done.

Operation.—Under spinal anæsthesia a McBurney incision, quite lateral, was made and the appendix was found to be retrocæcal in position, gangrenous and quite adherent to the parietal peritoneum and cæcum by old inflammatory adhesions. There was no perforation of the appendix and no evidence of any localized or general peritonitis. The appendix was removed, the base inverted in the usual manner and the wound closed after thorough irrigation with salt solution, a practice which is always carried out in all acute cases.

The patient stood the operation quite well and was in good condition when he returned to his bed.

Post-operative Course.—Twelve hours after the operation the patient's condition was quite satisfactory but during the second twelve hours his temperature went to 103.5° and the pulse to 130. With this there was marked abdominal distention, and marked restlessness with periods of delirium. The peripheral circulation was poor and there was considerable cyanosis. From this time on all of these untoward symptoms increased and did not respond to the usual methods of treatment. A large amount of salt solution was given as a continuous slow hypodermoclysis and glucose and soda was given by rectum. The abdominal distention persisted although the patient passed a large amount of gas with enemata. Gastric lavage showed no dilatation of the stomach and gave no relief.

Inspection of the wound thirty-six hours after the operation showed some œdema but no pus. A probe inserted through the skin edge at this time revealed no pus.

At this time (thirty-six hours after operation) the patient complained of pain in the right axilla and there was already some swelling in this region. A few hours later the swelling in the axilla showed definite crepitus and at this time (forty hours after operation) the wound was again inspected and thin yellowish pus was found on inserting a probe through the skin edge. The crepitus in the axilla ended at the costal margin and did not extend to the area of the wound. There was considerable œdema of the wound but no bronzing of the skin. A smear taken from the wound showed a pure culture of the Bacillus welchii. A blood culture taken at the same time also showed a pure culture of the Bacillus welchii.

The patient's general condition became rapidly worse and he died forty-four hours following the operation. He remained conscious until almost the end except for short periods of delirium during the second twenty-four hours. Autopsy was asked for but not obtained.

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Washington, D. C.

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MEMOIR

FRANK EMORY BUNTS, M.D.

1861–1928

Dr. Frank Emory Bunts died suddenly from heart disease on November 26, 1928. His departure brought a deep sense of loss not only to his many friends and associates among the physicians of Cleveland, but also to physicians, friends, and former patients throughout the world, who have at some time come under the influence of his kindly and genial spirit.

Dr. Frank E. Bunts.

Doctor Bunts was born in Youngstown, Ohio, in 1861, and received his education in the public schools. He then received an appointment to the United States Naval Academy at Annapolis, from which he was graduated in the class of 1881, which produced many other prominent men, among them Senator Weeks, Senator Weller, of Maryland, and Baron Uriu, who was Vice-Admiral of the Japanese Navy when Doctor Bunts visited Japan in 1922.

After Doctor Bunts had served for two years with the Asiatic fleet, the opportunity was given the younger naval officers to resign, because the Navy was overstaffed, and Doctor Bunts decided to leave the Navy and to study medicine, but all through his life and in all his relations he always bore the stamp of the Navy.

He matriculated in the Western Reserve Medical School and was graduated with the class of 1886. After graduation he became house officer at St. Vincent's Charity Hospital, with which institution he was associated in various capacities for the rest of his life—forty-two years.

In 1887 Doctor Bunts became the assistant to Dr. Frank Weed, who had a very active general practice on the west side of the city, including a great deal of casualty work. It was at this time that Doctor Bunts became interested in surgery. Doctor George W. Crile joined them in 1889, and after the

death of Doctor Weed in 1891 he and Doctor Bunts continued to practice together, associating with them in 1894 Dr. Wm. E. Lower.

Twice Doctor Bunts interrupted his practice to go abroad to study at foreign clinics, and later, during the Spanish War, he enlisted in the Army, serving as surgeon to the First Regiment of Ohio Cavalry under Major Runcie. He always retained his interest in military matters and after the war was over, in the midst of a busy practice, he became captain of Troop A and served in this capacity for three years. At the time of the World War he again accepted a commission as major, later becoming lieutenant-colonel and commanding General Hospital No. 9 at Rouen, France (Base Hospital No. 4, U. S. Army).

Doctor Bunts was a member of the Cleveland Academy of Medicine from the time of its organization in 1902, and was its first president. He was also a member of the Cleveland Medical Library Association, serving as its president in 1927. He was a member of the American Surgical Association, the Ohio State Medical Society, the American Medical Association, the American College of Surgeons, the American Association for the Prevention of Cancer, the Société Internationale de Chirurgie, and the Société Française pour l'Avancement de Science.

From 1886 to 1893 Doctor Bunts lectured on surgery at Wooster Medical College, and from 1893 until the time of his death he was Professor of Principles of Surgery and Clinical Surgery at the Medical School of Western Reserve University. He was visiting surgeon at various times to St. Alexis Hospital, St. Anne's Maternity Hospital, Mount Sinai and Cleveland City hospitals; consulting surgeon to the Lutheran, Women's and Maternity hospitals. He was one of the founders of the Cleveland Clinic Foundation and was chief of staff at St. Vincent's Charity Hospital from 1913 until his death.

Among Doctor Bunts' salient characteristics was his deep interest in civic and national affairs. He was a member of the Chamber of Commerce and served for years on its Committee on Military Affairs. He was a director of the Cleveland Trust Company. He was interested in and furthered every movement for civic improvement and was a frequent lecturer on patriotic subjects. He was a man of broad culture and wide reading, especially interested in articles and books bearing upon early medical history. In medical articles, many of which he was the author, and in the small volume of stories which he published some years ago his writing always showed a characteristic individual charm. He was a practitioner of the gentle art of fishing and the month each year spent at Rose Point provided many anecdotes which were a constant delight to his friends.

In 1888 Doctor Bunts was married to Miss Harriett E. Taylor and they were the parents of Dr. Alexander Taylor Bunts and of Clara Louise Bunts, wife of Edward C. Daoust.

It is difficult properly to evaluate this man. He possessed so many characteristics which make for greatness combined with a retiring, unassuming per-

sonality. Perhaps one may safely state that the keynote of his character was constancy—once he made up his mind to devote himself to any institution or cause, that cause or institution had his unfailing loyalty ever after. Every one of his patients became his lifelong friend in whose welfare he never failed to keep a lively interest.

An emphatic word should be added about his influence as a teacher upon the hundreds of students with whom he came in contact in the medical school and in the wards of the hospital. Patience and understanding, with insistence upon accuracy in diagnosis and refined surgical technic in operating, were outstanding characteristics of Doctor Bunts, the teacher.

There are certain individuals who possess the rare quality of binding together those with whom they are associated, due to high intelligence, industry, uncompromising justice, fidelity, patience, a deep understanding of human frailties, and unfailing friendliness. Such a man was Doctor Bunts.

GEORGE W. CRILE

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